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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Inversely Chilled Iron.

We have from time to time dealt with this subject, always hoping that some reliable British data and explanation would be forthcoming, but with the exception of Mr. Poole's discussion of the research work he carried out at the Keighley Laboratories, nothing has been published. The whole subject has been reviewed by Herr P. Bardenheuer in "Stahl und Eisen," as in Germany inversely chilled iron became a pest towards the end and after the war. In this country the phenomenon has been but spasmodic in appearance. As high sulphur and low casting temperature are intimately associated with the problem, it follows that the conditions are more likely to be met with in the future, as coke is not likely materially to improve in character, and scrap is taking up sulphur with every remelt.

Keep, in 1893, dismissed the phenomenon as a case of segregation. West, in 1912, tried to produce "inverse chill" artificially, whilst in the same year Osann suggested that oxides of iron might be the cause. Nielsen (1918) attributed it to high sulphur and low manganese, whilst another worker ascribed it to low carbon, high silicon, sulphur and phosphorus. The year following Pfalzgraf came along with the explanation that a rapid fall in temperature due to endothermic (heat-absorbing) reactions caused the trouble. The same year Schmid enunciated that the formation of graphite in the outside layers originating with the high silicon content exercises a pressure on the still liquid or plastic internal layers, which makes the separation of carbon much more difficult. About the same time Harnecker attributed inverse chill to the segregation of sulphur and phosphorus. In 1921 Frei ascribed the cause to extraordinarily high sulphur content, which on solidifying with iron sulphide evolved gas, which, by local cooling, prevented the separation of secondary graphite. We have previously dealt with or published the works of Osann, Poole and Young.

Bardenheuer in his research took three samples having the following chemical compositions:—

		Tot. C.	Gr.C.	Si.	Mn.	S.	P.	As.
1	Grey area	3.19	1.49	1.55	0.48	0.18	1.42	0.58
	White area	3.29	0.58	1.57	0.48	0.20	1.39	0.06
2		3.02	—	1.76	0.43	0.17	1.14	—
3		3.46	—	1.49	0.29	0.19	1.23	—

It is obvious that in all cases the P and S contents are high and the Si and Mn low.

It was found that in both the grey and white zones there was present the hypoeutectic structure of white iron, saturated crystals of cementite and the phosphide eutectic, but the grey zone, the cementite and phosphide eutectic are partly decomposed by the separation of primary carbon. Its structure is, however, clearly distinct from normal grey iron. Only in the case of Sample 2 could the presence of very small needles of graphite in the intermediate zone be found. The deduction can be drawn from these observations that the formation of graphite has only taken place when the solidification is completely finished.

The following phenomena are responsible for the formation of "inverse chill":—(1) Because of the chill found in "inverse iron" the normal formation of graphite has not taken place during the solidification period, and the iron has solidified in the white condition; (2) the external zone of the casting in the liquid state is in contact with the graphite of the mould, grains of sand and other foreign bodies, which form a series of centres for the formation of graphite.

However, because of the great quantity of heat absorbed by the mould, the metal solidifies very quickly, these centres cannot in the liquid alloy give rise to the separation of graphite eutectic (in lamellæ), and it is only in the solid alloy that the separation of carbon as graphite is brought about.

The solidification as white iron can be brought about equally well by chemical composition or by cooling conditions. Amongst foreign bodies, Ni, Al, and Si favour the formation of graphite, whilst Cr, Mn and S act against it. The influence of S is the greater the lower the Si. The experiments of Wüst and Minv show that the tendency of iron to remain white is accentuated by the S content.

XUM

It can be accepted that the separation of graphite in S-rich iron is always indeterminate, as apparently there exists in the relationship between the S and Si contents a critical value on one side or the other, the variations from which, even small ones, can either set up or completely prevent the formation of graphite.

The tendency to take the chill resulting from chemical composition is accentuated by the rate at which the metal passes through the solidification period. When the chemical composition is such that the iron may solidify in the white condition, the casting temperature actually determines the method of solidification. It has been found that inverse iron is almost exclusively encountered in the early cupola tappings, in which a higher S content is expected, and is usually associated with a lower metal-temperature—conditions now established as being favourable to the production of not only "inverse iron" but "hard castings in the machine shop."

The connection between "inverse iron" and badly-rusted scrap in the charges admits of explanation by the fact that the reduction of the iron oxide requires many heat units in the shape of coke. This obviously lowers the temperature of the cupola and increases the S content because of the extra coke used.

When a casting which normally would be expected to be grey solidifies as white iron, because of chill, and at the same time graphite centres are formed because of contact with the mould walls, it naturally follows that the cooling continuing, the carbide, which is found in the neighbourhood of these centres, decomposes. This decomposition in the solid solution is much more rapid than in the case of malleable iron, and limits the separation of a quantity of C, so that the concentration of pearlite is sensibly increased.

Bardenheuer outlines a successful attempt by Ruer to produce artificially "inverse iron." This worker used pure Swedish white charcoal iron as a base, mixed with pure graphite to give 4.3 per cent. C. He heated this mixture in a porcelain tube to 1,250 deg. C., maintaining that heat for a few minutes and then cooling in air. This gave him a typical "inverse iron." By quenching in water, he had a white fracture. By cooling in the furnace, a real grey fracture, containing well-formed needle-like eutectic graphite.

Though Ruer's tests do not take into consideration the influence of foreign bodies on the formation of graphite, the results obtained are comparable with practice, because the nature of a pure iron-carbon alloy is to solidify to the grey or white state, depending solely upon the cooling conditions. Even from that of an alloy in which the proportions of elements act in favour of the formation of graphite are found in a certain state of equilibrium.

The examination of thin sectioned castings often reveals a metal of which the fracture has the appearance of grey iron, but its fine structure is that of a white iron, and in which the cementite has been partly decomposed by the separation of graphite. On machining, the metal is hard and fragile. It thus presents a case strongly resembling that of "inverse iron." The solidification is first effected as white iron with nodules of graphite scattered throughout the section, and in the course of later cooling the carbide is partially decomposed in such a manner as to give the fracture the normal appearance of grey iron.

From this research it can be concluded that inverse iron is an iron which, having taken the chill, solidifies in the white condition, and the external zone of which has become grey, following the later formation of graphite. The cooling is principally due to a too-high sulphur content, which may or may not be associated with a too-low casting temperature.

AT THE LAST meeting of the Diesel Engine Users' Association, Mr. A. E. Farrow, engineer to the Windsor Electrical Installation Company, Limited, was elected president for the ensuing year, and Mr. Percy Still was re-elected honorary secretary. Messrs. E. W. Johnston, R. Birkett, and J. G. Griffin were elected to fill vacancies on the general committee.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

B.C.I.R.A. Malleable Specifications.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Although the letter in your current issue calls for no comment on my part, I will simply inform the writer that every member of this Association was advised as to this particular Specification as far back as October 28 last, and if the member he quotes will call at my office I will show him the copy of the circular in question, being resident in Birmingham it will be no trouble on his part. The Association always keeps every member firm fully informed as to the work of the Association.

This Specification was, I find, announced in no less than 14 technical journals, including THE FOUNDRY TRADE JOURNAL (November 2, 1922, page 354), and thereby drew applications for copies from all over the country, which were supplied.

I can only conclude, therefore, that your correspondent either does not read his FOUNDRY TRADE JOURNAL sufficiently carefully, or that his interests in the malleable trade are so small that he has forgotten that the usual course to obtain Government Specifications is to apply to the Purchasing Department concerned, which other foundries have done in this case.—Yours, etc.,

THOS. VICKERS,
Secretary, B.C.I.R.A.

Birmingham,
January 5, 1923.

Notes from the Branches.

London.

Owing to pressure of business, Mr. V. C. Faulkner has resigned the financial portion of the secretaryship. These duties will be undertaken by Mr. R. J. Shaw, of 57, Darwin Road, South Ealing, W. Members will oblige by sending direct to him their remittances. Mr. J. J. McClelland has been elected to the Council to fill the vacancy caused by the resignation of Mr. A. Bowman, who has left the district.

Deaths.

MR. T. W. HORSFALL, a director of the Campbell Gas Engine Company, Limited, died on December 18 in his 55th year.

MR. WALTER HOLLAND, of McKenzie & Holland, Limited, railway signal manufacturers, Vulcan Works, Worcester, died recently.

MR. J. A. HILL, proprietor of the firm of J. & P. Hill, machine tool makers, etc., Bernard Road, Sheffield, died on December 12.

MR. W. J. JOBLING has died at Harrogate at the age of 70 years. The deceased was a retired consulting marine engineer and shipowner.

MR. ALFRED PILDITCH has died at Wainfleet, Lincolnshire, at the age of 78. He was a former secretary of Palmers Shipbuilding and Iron Company, Limited, Jarrow, and was registrar of the company at the time of his retirement about 12 years ago.

Kiln-Dried Wood.—In order to settle whether kiln-dried wood is equal to that of air-dried timber, the forest products laboratory of the United States Forest Service made some 150,000 comparative strength tests on specimens from 28 different common species of wood. These experiments have showed that good kiln-drying and good air-drying have the same effect upon the strength of wood. The moisture content of wood on leaving the kiln is usually from 2 to 6 per cent. lower than that of thoroughly air-dried stock. Since wood increases in strength with loss of moisture, higher strength values may be obtained from kiln-dried than from air-dried wood; but this difference in strength has no practical significance, since in use a piece of wood will come to approximately the same moisture condition whether it is kiln-dried or air-dried.

The Grading of Pig-Iron.

By H. H. Shepherd, M.I.Brit.F.

Of recent years much has been written about the grading of pig-iron; authors of foundry text-books take particular care to point out that the only reliable and scientific way of grading is that of grading according to analysis, *i.e.*, according to composition. The writer's experience, however, has led him to believe that, whereas the old-fashioned and many present-day foundrymen relied entirely on fracture as a suitable means of grading, there is now a strong tendency on the part of the *modern* foundryman to rely on the analytical system of grading with the blind faith that was accorded to the old and crude system of grading by fracture.

Almost every paper read before foundry technical societies dealing with blast-furnace or foundry practice contains an appeal for the universal adoption of grading by analysis. At every turn the foundry is confronted with a powerful attack by science to break down the walls of tradition, conservatism, and secrecy, behind which the non-progressive foundryman seeks shelter.

The above is not to be taken as a defence of the old methods, the real case being that, whilst all the advantages that certainly are brought about by the adoption of grading by analysis have been emphasised, no warning is made as to likely pitfalls that may be encountered. With the exception of Mr. H. J. Young's speeches, careful perusal of most of the recent articles and reports has failed to reveal a warning note which the writer is of the opinion should be associated with any discussion dealing with the analytical classification of pig-iron.

Every progressive foundryman rejoices to see the old-fashioned and somewhat crude methods of the foundry swept away by the far-reaching advance of science, but care must be taken lest, in the hurry to advance, the crude, but valuable, knowledge assigned to us by our predecessors is forgotten.

Experimental Data.

In connection with analytical classification and its possible pitfalls, brief relation of an experience, during 1919-20, with two brands of pig-iron, will no doubt be of interest.

Of the irons referred to, one was of the siliceous class, the other a Staffordshire special All-Mine. For a considerable number of years the composition of these irons was almost constant, and was as follows:—

Siliceous.—G.C., 3.50; C.C., 0.10; Si., 4.60; S., 0.03; P., 1.30; and Mn., 1.00 per cent. *Staffordshire A.M.*—G.C., 3.50; C.C., 0.33; Si., 2.00; S., 0.03; P., 0.50; and Mn., 0.60 per cent.

These irons were present in the mixture to the extent of 25 and 15 per cent. respectively, and transverse test-bars, 42 in. × 2 in. × 1 in., cast from the mixture, gave test-values which were never below 28 cwts. for the breaking load, and 0.33 in. for the total deflection. Invariably the breaking load reached 30 cwts., from the date of the adoption of the mixture, until trouble manifested itself by a sudden and maintained drop in the test values. This particular mixture had been in successful operation for more than twelve months, and the sudden occurrence of trouble led the writer to believe, at first, that the melting practice had varied from normal; but careful investigation showed that the solution of the problem did not lie in this direction, so attention was turned to the pig-iron. Analyses were made of all irons used in the mix, and the result of this was, that they were found to agree with the makers' analytical specifications and with the composition of previous consignments.

The average analysis of the iron in the test-bars which gave poor results, and of that in test-bars which gave good test values, is shown by the following figures:—

Poor Bars.—G.C., 3.20; C.C., 0.46; Si., 2.48; S., 0.09; P., 0.88; and Mn., 0.57 per cent.

Good Bars.—G.C., 3.30; C.C., 0.40; Si., 2.47; S., 0.09; P., 0.97; and Mn., 0.50 per cent.

The above figures show that there was practically no variation in the composition of the iron contained in the test-bars. The small variation that is apparent is in favour of the best iron being contained in the bars which gave low results; these indicated an average of 25.50 cwts. for the breaking load and 0.275 in. as the deflection, the tests being conducted on 42 in. × 2 in. × 1 in. (36 in. centres) bars.

As stated, it was at first thought that the melting practice was at fault, this opinion being formed after brief examination of the test-bar fractures; the grain was observed to be abnormal in size. Towards the centre of the bars the fracture developed into that of a No. 1 pig-iron. But, as it was later proved that the melting had been properly carried out, and that the composition of the pigs and of the mixture was correct, it was obvious that the trouble lay in the physical condition of one or more of the pig-irons comprising the mixture.

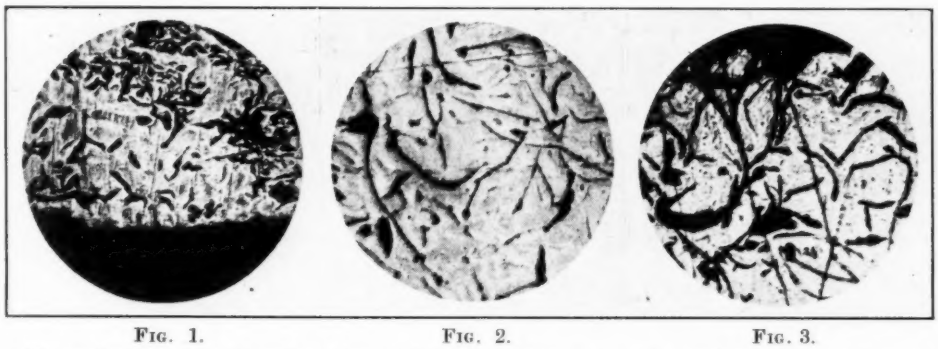


FIG. 1. Micro-section taken from the underside of the transverse test bar on the 1 in. surface immediately beneath the fracture.

FIG. 2. Shows the graphite plates to be larger. It has been cut from a position equi-distant between the bottom face and the fracture.

FIG. 3. The graphite plates are still larger. This section is taken at the fracture.

The method of overcoming the difficulty, and ascertaining the actual trouble, involved a preliminary examination of the irons. By grading *according to fracture*, it was found that, while the other constituents of the mixture were correct in every way throughout the stock, the two brands of pig varied considerably. Some of the stacks which were in use showed, in the case of the siliceous pig, a grain size which, even for this type of iron, was a remarkably open one, and stacks which had not been used contained good and bad iron. Similarly with the all-mine pig, this should, as its composition indicates, have possessed a very close grain, yet fully 40 per cent. of the consignment dealt with was of a fracture equivalent to that of a normal siliceous iron.

Combined Method Advocated.

Grading carefully by means of a *combination* of the analytical and the fracture systems, enabled the amount of abnormal iron to be so proportioned with the close grained, and with a close No. 3 Derbyshire foundry, that the trouble was eliminated, and the test values were restored to normal.

The average analysis of the iron contained in transverse test-bars, cast during a six days'

"run" of the new mixture, gave the composition as:—G.C., 3.34; C.C., 0.34; Si., 2.50; S., 0.095; P., 1.04; and Mn., 0.74 per cent. The average test values were 30 cwts. and 0.35 in. for the breaking load and deflection respectively.

The experience related made it clear to the writer that the mere knowledge of the composition of pig-iron is *not in itself* an absolute reliable means of grading, no more than is an expert knowledge of pig-iron fractures, but by the *combination of the two methods* it is possible to evolve a system of grading which is *complete*, reliable, and scientific.

The criticism which the writer ventures to put forward, in regard to the widely-propounded system of "grading of pig-iron according to analysis," is that it is incomplete, is not always reliable, and therefore cannot be termed strictly a scientific method; also that, unless its likely exceptions to the rule are made known as widely as its ascendancy over the old method of grading has been, it is likely to lead to serious misunderstandings, particularly amongst students.

System for Acceptance.

At the works with which the writer was connected the following system of check grading was adopted. From each truck of pig of 5 tons, or less, three pigs were selected from different parts of the truck, whilst, if there were more than 5 tons, five pigs were taken. These were broken into half; a variation of one or more of the pig fractures resulted in another sample being selected. The retention or returning of the iron to the maker depended upon the composition and the *fracture* of the iron, on the amount of variation existing, and the weight of the incorrect iron found by sampling, grading and analysis. In this way the foundry was kept free from further trouble in the direction dealt with, although the same fault was detected in a consignment of Scottish iron.

Cause of Open-Grained Iron.

The faulty irons were, for the most part, taken from Government stock, which was made during the war, and probably at a time when the blast furnaces were working at their highest pressure to meet with the—then—ever-increasing demands of the Ministry of Munitions. It has been suggested that the temperature of the melting zone of the furnace was, owing to increased blast pressure and temperature, such that the iron became super-heated to such an extent as materially to affect the physical properties.

All attempts to close the grain of the pig-iron, without the admixture of other irons or of steel, or by increased blast, met with little success, and it is the writer's opinion that such iron cannot, by ordinary cupola melting practice, be converted into normal iron as regards strength and structure. The accompanying photo-micrographs were taken from a transverse section of one of the bars which gave poor results, No. 1 specimen being cut from a point on the 1-in. side of transverse test-bar opposite the centre of the fracture, No. 2 midway between No. 1 and the fracture, and No. 3 at the fracture. The specimens were not etched, but were very finely polished. The magnification, 90 diameters for each photo-micrograph, has been but slightly reduced in reproduction.

Fig. 1 is of a section of the bottom edge of the transverse test-bar; massive graphite is shown to exist throughout the whole of the edge. Fig. 2 was taken at a point about ¾ in. from the bottom edge; note the large increase in the graphite size. Fig. 3 is of the fractured edge, the section of the test-bar being partly sawn through and then broken into two portions, the fracture occurring about halfway up the section. The remarkable size of the graphite gives one an idea of what its condition was in the original pig-iron comprising the mixture from which these bars were cast; and that mixture included 40 per cent. of returned scrap, consisting of rejected castings, feeders, runners, etc.

Particular attention is drawn to the tremendous flake of graphite, which extended from the fractured edge of the test-bar section right across the specimen, where it ended in a "lake" of massive graphite, not shown in the photo-micrograph.

Book Review.

AMERICAN MALLEABLE CAST IRON, by H. A. Schwartz. Published by the Penton Publishing Company, 2-3, Caxton House, Westminster, London, S.W.1. Price 35s., post free.

In his preface, the author states that, "Guided by the injunction of Leonardo da Vinci, confirm your statements by examples and not by assertions," it has been the author's constant effort to record facts rather than opinions wherever possible." Unfortunately, the author rather badly breaks his resolve in the first chapter, if not by direct statement, then by innuendo, which is perhaps worse. Again to quote the text, Mr. Schwartz states, "In 1722 Reaumur, a French physicist, described a process, *not necessarily original with him*, for producing malleable cast iron by packing small castings of (presumably white) cast iron in pulverised hematite ore and heating them to bright redness for many days." The italics are ours, and are present to emphasise da Vinci's hypothesis, which would require an example of an earlier experiment on similar lines given by some authoritative contemporary or earlier writer. We have received the impression—we hope without good cause—that the author holds a strong brief for Seth Boyden and a poor one for de Reaumur. Our impression has been received from statements on pages 12 and 13. On the latter page appears the following:—"Black heart or American malleable cast iron bears no metallurgical relation to the European product, and its history begins not with Reaumur but with Seth Boyden." On page 12, what can be construed into a contradiction, appears. "Boyden was a manufacturer rather than a scientist. Probably for this reason no formal announcement of a new discovery was made. It is presumed that in attempting to duplicate European practice with American pig-iron, which is low in sulphur and high in manganese, he inadvertently discovered an alloy which when heated to produce decarburisation, graphitised instead."

The real interest for British readers starts with Chapter III (metallography of malleable iron), and from there on to Chapter XIX. we have nothing but praise.

The book is divided in nineteen chapters, and deals most exhaustively with every phase of blackheart malleable manufacture, and can now be considered as the standard work on the subject. This work, together with Professor Touceda's monumental contribution on the subject given to the last annual meeting of the Institution of British Foundrymen, should form an excellent base on which to build up a similar industry in Europe. The importance of European foundrymen knowing all about American malleable iron cannot be exaggerated, as some important Continental railway contracts are specifying this material.

The illustrations and diagrams are excellently reproduced, and number close on 200. Every ferrous foundryman, whether interested in this particular phase of metallurgy or not, should procure a copy for his bookshelf as the general information will help him better to understand the problems associated with his work.

Contracts Open.

Dundee, January 15.—Supply of about 75 tons of 4-in. internal diameter cast-iron pipes, for the Dundee Water Commissioners. Mr. G. Baxter, jun., waterworks engineer, 93, Commercial Street, Dundee.

Harrogate, January 27.—For the duplication of two inverted cast-iron siphons, including the provision and laying of about 816 yards of 21-in. and 902 yards of 24-in. cast-iron pipes, with penstocks and other specials, for the Town Council. Mr. C. E. Rivers, borough engineer, Municipal Offices, Harrogate.

Cheddleton, etc., Staffs., January 22.—For the provision, laying and jointing of about 15 miles of 8-in., 7-in., 6-in., 5-in., 4-in., and 3-in. cast-iron mains, together with valves, hydrants, etc.; also the construction of engine-house and two reservoirs having capacities of 250,000 gallons and 100,000 gallons respectively, in connection with the Cheddleton, Caverswall (part) and Consall (part) water supply, for the Cheadle Rural District Council. Messrs. Willcox & Raikes, 63, Temple Row, Birmingham. (Fee, £10 10s., returnable.)

The Foundry Cupola.

By Robert Buchanan (Birmingham), Past President of the Institution of British Foundrymen.

(*Continued from page* 13.)

Grading by Fracture and Analysis.

An important quality necessary in one who aspires to successful cupola management is a knowledge of the material with which good results are to be obtained. For this purpose he should know the general effect of the several constituents present in pig and scrap iron, the modifications which these undergo during their passage down the cupola, from the solid to the molten condition, and the effect of the constituents upon the general condition of the casting produced.

It is here that the chemist and founder may co-operate towards that desired end. Chemistry may not be an infallible guide, nor may it account for some of the unexplained phenomena seen in the manipulation of iron into the finished product, but it has shed, and will certainly still further shed, a light to guide foundrymen with more certain steps along a path too long beset with the stumbling blocks and pitfalls of ignorance.

Is the fracture of pig-iron a guide to its quality? The reply is "Yes" and "No." Fracture has been, and is now, the only guide which many founders have regarding the quality of the irons they use. However that may be, it is inevitable that, be it soon or be it late, judging pig-iron by fracture shall give place to the more precise test of analysis.

Physical structure may sometimes differ in irons of similar analysis, and discordant results follow tests of these irons, but the broad fact remains that in the great majority of cases the same physical effects follow the same chemical constitution. If the exact effect on physical structure of all the constituents present in pig-iron be not yet definitely ascertained, if ever it be ascertained, yet there exists a fairly full knowledge of the general effect of chemical constitution upon physical condition.

Limitations of Chemical Analysis.

To give an example of the limitations of chemical analysis as indicating the probable physical characteristics of the iron the following may be mentioned. Some years ago at certain Swedish blast furnaces an experiment was tried with a view to increasing the output of the furnaces. An increased quantity of blast was used, and an iron produced of the exact analysis of the iron previously made. The increased output was obtained, but the strength of the iron had deteriorated. It is quite possible to match by analysis a cold-blast iron with a hot-blast iron, but the cold-blast iron is almost invariably the stronger of the two. This is probably due most of all to the size of the flakes of graphite, or free carbon, in each case. Hot-blast iron has large flakes of graphite; cold-blast iron has the graphite in a more finely divided form. A heavy blast at a high temperature supplies the conditions for the production of large graphite flakes in the pig-iron. A cold, or moderately heated, blast supplies the conditions for the production of fine graphite. The height of the blast furnace has also an effect on the quality of the iron produced. This is probably owing to the longer time during which the iron ore in a high blast furnace is subjected to the influence of the various gases in the furnace.

All irons contain gases, but it is obvious that the less gas they contain the better they will be. Professor Carpenter has carried out a number of interesting experiments in proof of the fact that hydrogen gas is the principal one found in cast iron. It is obvious that a small furnace, so far as height is concerned, will subject the ore and the metal to less gas inclusion.

In the Swedish experiment previously mentioned the conclusion was formed that it was the contained gases in the iron made in the heavily blown furnace which caused the deterioration of the strength. Probably the size of the graphite so produced had something to do with the loss of strength.

It has to be noted that cold-blast irons are almost invariably made in small furnaces. Easy blowing, with a moderately heated blast, using a small furnace, give an iron which comes midway between cold-blast and hot-blast iron as regards quality. The size of blast furnace, volume and temperature of blast, as well as the kind of ores used, are all important when the quality of the pig-iron to be produced is considered as the principal factor.

Whether the volume and temperature of the blast be high, moderate or low, so will the physical characteristics of the pig-iron produced vary. There is little doubt that these differing physical qualities are largely due to gaseous inclusions in less or more degree, and also to the quantity of total carbon present and the size of the graphite flakes.

Coke.

Coke for cupolas should have the ash and sulphur as low as possible, but even in coke of good reputation these vary considerably. During the past six or seven years coke has deteriorated very much as regards ash, sulphur and density of structure. When sulphur is high in pig-iron it almost invariably reveals its presence by closing the grain of the iron, but when present in coke it is principally revealed by the hard castings it causes. That is, unless the sulphur in the coke is in very great excess it is not visible to the eye. If one has to use high sulphur coke copious limestone and hot melting are the principal means to be used to overcome the difficulty. Lime has an affinity for sulphur, and the hotter the cupola is so will be the activity of the slag to take up the maximum of sulphur. That is why the first iron from the cupola is usually harder than what it is later on. In an average of ten analyses of coke the lowest sulphur was 0.530, the highest 1.068, and the average 0.769 per cent.; whilst the ash content ranged from 6.52 to 10.30 per cent., the average being 8.604 per cent. The coke, with 1.068 per cent. sulphur, caused much trouble by hardening the castings.

Coke with 90 per cent. carbon may be considered satisfactory in this respect. Carbon should not be allowed to drop below 86.5 per cent., as even at this percentage a marked difference in the melting power is noticeable, as may be expected. Coke with 91.78 per cent. of carbon is the highest carbon the author has encountered. Manganese in the pig-iron up to 1½ per cent. is useful in reducing sulphur in castings. Some of the manganese combines with some of the sulphur and goes into the slag.

Cupola Fluxes.

The principal flux in use for cupolas are limestone and fluor spar. Owing to their geographical position, some foundries use chalk, and others oyster shells. That is, lime in one or other form is used to combine with the sand on pig-iron or scrap, and so form a fluid slag. As already mentioned, one important function of the slag is to take up as much sulphur as possible, and so help to keep the iron soft.

The quantity of limestone used per ton of iron melted varies very much in different foundries. The author's own practice was to use 56 lbs. of limestone per ton of iron melted, and this quantity of limestone produced a fluid slag which was of a greenish-brown when cold. Some good founders use less than 56 lbs. of limestone per ton of iron melted, but the quantity of limestone should certainly not be less than 40 lbs. per ton of iron.

It has to be remembered that if the sand on pig and scrap does not have sufficient lime to combine with then it will form slag by combining with iron. When the quantity of limestone is deficient one gets a black, glossy slag with considerable iron in it. When the slag is a dead-black colour it contains a very high percentage of iron. One of these dead-black slags contained about 30 per cent. of iron. It ought to be mentioned that when it was produced the cupola was working very badly.

Fluor Spar.

This flux gives a very fluid slag, but care has to be exercised as regards the origin and kind of fluor spar used, as some contain very appreciable quantities of sulphides. The author carried out a number of experiments to test the utility of fluor spar as a flux as compared with limestone. As the limestone was already giving a slag sufficiently fluid, it was simply a question of how much more sulphur the fluor spar would cause to enter the slag. Fluor spar alone, and various proportions of limestone and fluor spar were tried. The conclusion formed was that fluor spar as a flux was little, if anything, better than limestone, and cost very much more.

One drawback to the use of fluor spar is the fact that in the cupola it gives off fluorine gas, a true poison gas; when a "blow-down" takes place at the charging door it may be necessary to help the cupola man off the stage if he has got a breath of the gas. This was an actual occurrence.

Limestone used for fluxing should be analysed, as a small difference in composition may alter considerably the character of the slag, either in the molten condition or when hard and adhering to the lining of cupola and ladles. It should be low in silica and oxide of iron. Table I. shows two analyses of limestone:—

TABLE I.—*Analyses of Limestone.*

	(1)		(2)
Calcium carbonate ($CaCO_3$)	98.02	...	95.01
Magnesia (MgO)	1.05	...	—
Silica (SiO_2)	0.43	...	4.16
Alumina (Al_2O_3)	0.20	...	0.40
Iron oxide (FeO)	0.23	...	0.43
Manganese oxide (MnO) ...	0.07	...	—

The limestone marked (2) formed a slag, remarkable for the difficulty with which it could be detached from the walls of the cupola and receiver when chipping down preparatory to fettling for another cast. The limestone marked (1) is superior to the other in respect of the higher percentage of calcium carbonate and comparative freedom from silica.

Cupola Linings.

These usually consist of fire-brick, and so far no other material has been used to any noticeable extent. When building in the lining the fire-clay joints should be as thin as possible, with just enough fire-clay to keep the bricks from rocking. It is clear that a fire-clay joint is not so hard as a well-burnt fire-brick and resists the heat less.

It does not follow that the purity of the material from which the brick is made provides the best brick for cupola use. The silica brick used in the roof of a Siemens furnace for melting steel is a case in point. This brick has just as much fire-clay in its composition as will bind the silica grains together. The silica brick is readily corroded and worn away by the slag which it helps to form, and is too friable to stand the rather rough usage which cupola bricks have to undergo. Also, if the silica bricks become wet they "spall" off and go to pieces. When silica bricks are in the roof of a Siemens furnace they are not in contact with metal or slag, and have to withstand heat only.

Experiment with Basic Linings.

Some years ago experiments were made by the author to ascertain if a basic-lined cupola would be an improvement over the ordinary fire-brick lining. The lining was similar to that used in the basic "Bessemer" convertor, or other basic-lined furnace. This lining consists of burnt dolomite mixed with boiled tar as a binder. A cylindrical wooden plug of the desired diameter was used, and the material was rammed into position by men using heated rammers. After firing the new lining well for 24 hours or so the cupola was charged in the usual way. It is to be noted that the cupola has a drop-bottom and a receiver, the bottom in each case being made up with moulding sand. The massive connector-brick between cupola and receiver was of ordinary fire-brick composition. When about 6 tons of iron had been melted the molten iron began to drip through the drop-bottom and was stopped, after putting off the blast, by ramming in fresh sand. It was found that the sand originally forming the cover for the drop-bottom doors was almost wholly fluxed away by the highly basic slag. The melt was finished, and at its conclusion it was found that a channel 2 in. deep had been cut along the connector-brick betwixt cupola and receiver. Various expedients were tried to prevent these happenings, but without success. Finally, the rain entering a crack in the cupola shell caused a part of the new lining to be blown inwards, with the result that a fairly large hole was burnt in the shell. This concluded the experiments with a basic lining.

One phase of these experiments was the use of anthracite coal-dust, with boiled tar as a binder, in the bottom of the receiver. This bottom lasted well, but metal was apt to come through at making-up doors, or anywhere else where sand was used.

Seeing that the anthracite and tar had lasted well in the bottom of the receiver, it was thought that possibly a similar mixture would do for lining the cupola. The basic lining mentioned had to come out anyhow.

The anthracite coal-dust mixed with boiled tar was rammed round a plug with hot rammers just as in the previous case. When the cupola was put to work it melted good hot iron with less coke than ordinary, but the lining gave quite an illumination to the vicinity. Gas flames were coming from every crack and hole in the shell, and the attention these drew was somewhat embarrassing. This lining was used for a week or so, and was then stripped out and the proved fire-brick lining put in.

Charging the Cupola.

Assuming that the bottom of the cupola is in good order, the inside contour of lining free from sudden changes of diameter or projecting knobs of slag, which may hinder the regular descent of the charges of coke and iron as melting proceeds, the first thing to do is to ascertain the depth of bed necessary to begin the melting. It is the upper part of the bed which melts the first charge of iron. The coke in front of the tuyeres does not melt the iron, unless it be indirectly.

The action is as follows:—When the blast strikes the coke immediately in front of the tuyeres, carbon dioxide, or carbonic acid, is formed. The carbon dioxide so formed, passing up through the next layer of incandescent coke, is immediately reduced to carbonic oxide, which, combining with the free oxygen of the blast, produces the intense heat of the melting zone and passes up the cupola as carbon dioxide. There is also some unconsumed carbonic oxide which escapes up the cupola, and is to be seen burning in the chimney or stack. The presence of unconsumed carbonic oxide in the cupola is not altogether an evil, as it prevents, in some degree, oxidation of the iron. The melting one is the section of the cupola where the combustion of the carbonic oxide is practically begun and completed with the production of a most intense heat. It is certain that the actual melting is done by flame-action, not by actual contact of iron and incandescent coke.

The region of highest temperature, as indicated by the wear of the lining, is at the top of the melting zone. The position and depth of the melting zone is fixed by the quantity and pressure of blast used, but may vary to some extent as tuyere area and cupola diameter vary.

It is a most important fact to remember that no actual melting takes place until the metal reaches the top of the melting zone, no matter how much coke is put on above the zone. Were it piled 4 ft. high the coke is simply burned away until the iron gets down to the melting zone, where it at once changes the solid for the liquid state, and so drops to the hearth.

(To be continued.)

HYATT, LIMITED, have appointed Mr. Evans Morgan, 15, Vyvyan Terrace, Clifton, Bristol, to represent them in South Wales and district, the agreement with their previous representative, Mr. G. Tottle, having expired on December 31 last. In the paragraph announcing the appointment of Mr. G. A. Chapman to the Manchester district, published in our issue of December 28, we regret that the firm's name was given as Hyam instead of Hyatt.

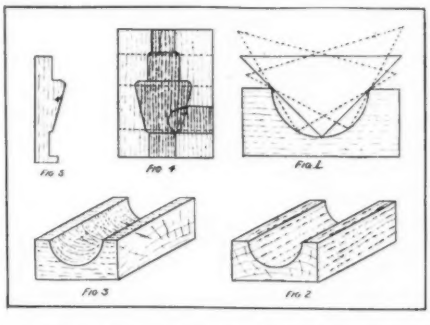
An Apprenticeship Course in Foundry Practice.—XXV.

By Ben Shaw and James Edgar.

THE CONSTRUCTION OF CORE-BOXES.
Part I.

Scope of the Article.

In a previous article on cores some important generalisations were made on the construction of core-boxes, but in this article we shall endeavour to deal comprehensively with core-box construction in a way which, while of interest to apprentice moulders, will be of primary usefulness to apprentice patternmakers. The proper construction of core-boxes is as difficult as the construction of patterns; indeed, in many cases they are more difficult; thus it is quite common for a foreman patternmaker, in giving out work, to allot core-boxes to the men in whom he has the most confidence. When a man goes through a job making pattern and core-box in turn, he has to study the cores when making prints and also in many cases in defining the shape of the pattern, and in this way he almost subconsciously determines how the core-boxes can best be made. Were he to reverse the process and make the core-boxes first—a practice which is sometimes done when available lathes for turning the pattern are occupied—the construction of the core-boxes would be a more difficult matter. Core-box work tests the patternmaker's knowledge of foundry work equally as much as making patterns. It is no uncommon thing for a core-box to be sent to the foundry of



excellent workmanship but displaying no conception of what is required. The patternmaker, when he examines his drawing, has to visualise the mould, he has to know where the moulder will make joints and what parts will be taken off as drawbacks, in order that he may be able to decide whether the core should be in one or several parts. Even when one core-box is practicable it may be inadvisable because of its clumsiness and the probability of its being broken in handling. In some patternshops when it is known that the core must be in two or three parts only one core-box is made, and the core-maker is left to make his own divisions with the aid of paper or tin. This may be economical patternmaking but it is costly core-making and seldom justifiable. An argument which is at times cited for this is that when the core is intricate and when there are many internal ribs and divisions, the moulder can measure thicknesses and when setting cores can compare them with the box. There may be something to be said for this, but if a good drawing is supplied and metal thicknesses are plainly set out on pattern and core-boxes, there should not be any confusion. Perhaps the only cores for which it is justifiable to make one core-box are some valve cores, because in these cases the valve seat forms a division and two core-boxes are really constructed as one.

Important Considerations.

Much that has been said about pattern construction is equally applicable to core-box construction. In large boxes, the bottom and sides of which have to be made of several widths of timber battened together, joints should be open. There should be as few loose pieces as possible, and when some are necessary, except for one-off jobs, they should be dovetailed or dowelled in position in order that they may be accurately replaced. It is very important that in rectangular cores as much taper as possible should be allowed, and this applies also to ribs that are at right-angles to the horizontal joint of the box. What should always be aimed at in core-box construction is accuracy coupled with durability. The possibilities of errors is much greater with core-boxes than with patterns. It is so easy to overlook a rib dividing a steam passage, or a small facing may be forgotten which will render the casting useless. When several core-boxes have to be made for one core and several men are employed on the job a mistake is very possible, and for this reason a careful inspection of the various boxes by the man in charge is necessary. When it can be done, the core-box should be placed on top of the drawing board, although this cannot be done as easily as with patterns.

Use of Templates.

Templates are indispensable when making core-boxes, but it is wrong to make a fetish of them. The 90-degrees setsquare is more valuable because it is more accurate than any template, when cutting boxes for semi-circular cores. The angle in a semi-circle is a right-angle, therefore when a box has to be roughened out, it may be freely tested with the setsquare (see Fig. 1). Neither soft-wood templates nor wood setsquares should be used, the metal setsquare being preferable to one made of hard wood. The skilled craftsman does not press the point of the setsquare into the work but simply touches it in a few places, and a gouge of just less radius than that being cut and a trained eye will enable him to take out what is necessary. Confidence and skill enable some men to carve an irregularly-shaped core-box in a fraction of the time taken by others. Screws should be used in preference to nails for core-box work. It is quite inexcusable to nail battens on core-boxes, although the writers have seen this done with the points of the nails clinched over. This prevents a face being planed, and is not much quicker than screwing. Glue is usual as a temporary expedient for joining several parts that have to be carved, screws being inserted after the shape has been formed. With regard to joints for core-boxes, the plain housing-joint is used for framed-boxes.

The tools used for cutting core-boxes are firmer, long, thin, paring- and cranked-gouges, and carving tools. The cranked-gouge should not be used as a general rule, if it is possible to employ a straight paring-gouge, but they are of great value for long cores.

In shops where there is a wood milling machine it is good practice to joint-up the core-boxes at the same time as the pattern in order that the machined work can be done while the pattern is being made. In marking off core-boxes sizes should be set down slightly smaller than required, because it invariably happens that if measurements are accurate when the core-box is being made it will be found to be just " full " when it is assembled. For instance, when two halves of a core-box are joined after cutting it will usually be necessary to trim the joint.

Small Cylindrical Core-Boxes.

When a small cylindrical core-box is long, the grain will be as shown at Fig. 2, but when short it will be as at Fig. 3. Assuming that instead of the core being of one diameter throughout its length, that it is what is sometimes called a " bottle-necked " core, that is, with the diameter changing at some point of its length and having a square shoulder at this point, or it may be a chambered core in which for a certain distance in the centre the diameter is greater than at the ends. If the grain of the wood is almost perfectly straight there would be no great difficulty in cutting the shape; the best practice is to finish

the small core-shape first; but if the grain is twisted it is exceedingly difficult to get a satisfactory result. For this reason it is not uncommon even with long cores to make the grain across the core shape. Sharper tools are required for cutting end grain, but a much better result is obtained and in less time.

Common Type Valve Core-Boxes.

A box from which an apprentice can learn a great deal is the type shown at Fig. 4. In small sizes it is customary to cut the whole shape from one solid block. The branch core shape is nearly always cut through the side, and not through the bottom. For such valves, even when there are two branches, it is not usual to cut the core shape of one through the bottom of the box, but to make a separate cylindrical-shaped core to fit on the main core. In cutting a core-box like Fig. 4, the end shapes should be cut first, after which a template similar to Fig 5 can be made for the main core shape, the ends bearing on the previous-shaped ends of the box. The branch core shape should be the last to be formed, although a careful workman can save some time by cutting it before the main core shape. The core-box just described is for a single-valve chest, but it is quite common to have two, three, or more valves as one casting, and it is then advisable, unless for small sizes, to make the core-box in sections. Suitable joinings are indicated by the dotted lines in Fig. 4. This allows good fillets to be cut. The various widths ought to be correct so that it is possible to clean up the completed box. A point of contention is as to whether the whole core-box should be first built, the core shape set out, then dissembled, and then cut out, or the various parts finished before they are screwed together. The truth is that it is quite immaterial provided care is exercised, and the latter method is without doubt the quicker. Before leaving this class of valve pattern let us consider the valve seat. Sometimes these are simply made of hardwod wired on to the box, and they very soon get broken. An improvement on this is the plywood washer with a considerable taper on the outside diameter, which is made $\frac{1}{8}$ in. or 3/16 in. thicker than required, the extra thickness forming a dovetail. It is very common now to make valve seats in core-boxes of metal, either brass or aluminium, and for standard work this is an excellent practice, because while plywood is satisfactory up to a point, yet, even when well varnished, the different thicknesses tend to separate after being in use for some time. For metal seats the patternmaker prepares a pattern to the exact sizes, and the resultant castings being slightly larger, due to rapping, enabling them to be touched up with a file to finish them.

The Dunswart Iron and Steel Works.

The Dunswart Iron and Steel Works, in South Africa, were initiated by private enterprise and capital on the Rand about eleven years ago, and encouraged by war conditions—when the mines and railways, deprived of other sources of supply, were largely dependent upon it—have in a short period grown into a prosperous and thriving concern, and still show signs of all-round expansion. In their recently enlarged and extended form the works to-day cover some thirty acres at Dunswart, situated alongside the main line of railway and the Main Reef Road. A labour staff of 85 white men and some 350 natives is employed, and though many of the skilled workmen have had to be imported, a large number are now drawn from the youth of the country who have served their apprenticeship at the works.

The plant is equipped with all the latest appliances of modern rolling mills. The chief features are one 8-in. and one 12-in. 3-high steam-driven rolling mills, and an 18-in. 3-high electrically-driven cogging mill. These mills are supplemented by a 5-ton steam hammer. In the blacksmiths' shop, which has been enlarged and refitted, is a 1,200-lb. steam hammer, and the machine shops are fully equipped with the latest machine tools. An Avery railway weighbridge for weighing trucks is installed, in addition to which there are various scales fitted throughout the works tramways. Apart from a Héroult electric furnace, the equipment comprises a furnace for puddling iron—the only one in the country. All the industrial buildings are steel-framed, sheeted with galvanised iron, and the manager's house, offices and store rooms are all substantially built of brick. The native compound has been modelled on the lines of the best mine compounds, and the area of land owned by the Company gives ample scope for expansion.

The new Héroult furnace with its equipment of ladles, ingot moulds, and overhead electric crane, is capable of producing about 30 tons of steel per day from scrap. For the present, the Dunswart Company are concentrating on mild-steel rounds, squares, flats, angles, and steel castings, but later on it is their intention to extend their operations considerably. The bars turned out conform to the British Standard Specification for reinforcing bars. The tube-mill bars are of high-carbon steel. Every cast of steel from the furnace is analysed and a proper record kept for reference. The electric power used is purchased from the Victoria Falls Power Company, which recently announced their intention to augment their plant in order to cope with all future demands of local industries.

Stainless Steel and Iron.

Metallurgical progress in 1922 is recorded, and many developments of earlier discoveries have taken place. Non-rusting and stain-resisting alloys have received profound attention. Of such stainless steel and iron are probably of greatest interest, reaching the public in the form of cutlery, household appliances, nameplates, hearth furniture and such like, while for the motorist there are radiators, car fittings and adornments. Developments have proceeded to such an extent that cans, cutting-tools, meat hooks, valves, engine parts, chemical appliances, all kinds of stampings and forgings are now being made. A big forward step is the casting of such material into a million and one forms which, after tempering and polishing, become for all ordinary purposes perfectly stainless.

Chromium still remains the chief alloy addition, generally as ferro-chrome, to secure such results. The price factor is still, however, a big obstacle to universal use.

An interesting development of 1922 still in its infancy is the use of chromium as a plating medium. Covering baser metals with silver, nickel, cobalt (to a minor extent), zinc, etc., by electrical processes to secure various effects, such as cheap substitution for solid articles, chemical resistance, artistic effects, commercial utility, and in some cases rust resistance, are well known, but the application of chrome electrolytically deposited for stain-resisting purposes has hitherto been unsuccessful.

Its commercial success is not yet fully established, but promises well in many directions, and the New Year will see many developments.

In non-ferrous metals and alloys nickel has long been known to have powers of resistance to oxydisation up to a point, and developments here are noted. These chiefly concern the nickel alloy used so extensively in the electro-plate trades and known as nickel silver (German silver), where by the raising of the nickel content to over one-third and the addition of a small percentage of tin, a white metal results which takes a high polish, is hard enough to withstand rough use, but does not need plating, and will at the same time keep its colour and resist tarnishing. It is Sheffield's counterblast in the cutlery trades to stainless steel, and is in increasing demand for spoons and forks. The general interest is, however, not so strong as stainless steel, and its success as a permanent resister of tarnish still requires proof. Much experimenting is taking place in many non-ferrous metals, and a very beautiful sterling silver alloy, which will not tarnish or stain, will shortly come on to the market.

MR. H. E. OVING, JUNR., chairman of British Steel & Iron Exporters, Limited, London, and a member of the Iron and Steel Institute, has received the high honour of Knight Officer of the Order of Oranje Nassau, recently bestowed upon him by H.M. the Queen of the Netherlands. Mr. Oving has been associated with the iron, steel and engineering industries for 50 years, and is well known in the trade, not only on the Continent, but also in Great Britain and the United states.

Institution of British Foundrymen.

SHEFFIELD BRANCH.

Discussion on Mr. Smalley's Papers* on "The Effect of Special Elements on Cast-Iron."

The BRANCH PRESIDENT (Dr. Swinden), in calling for discussion, said the subject was a very ambitious one. In many cases the author had given them, in a single sentence, the result of weeks and months of work. Perhaps the only criticism that one could level was that there was so much of the Paper that it was difficult to single out any one point to criticise in detail, and it would be very unkind to do so. He was sure they all appreciated very much the opportunity of hearing Mr. Smalley on this, to his mind, new phase in the metallurgy of cast iron.

MR. SHAW said he had had experience of a very small amount of work on chromium, but it bore out to a great extent what Mr. Smalley had said. It produced a mottled back to some of the chilled work that they did not expect from the composition of the metal otherwise. He must confess that the result of the aluminium was a revelation to him. He had used aluminium as a scouring agent, but was quite ignorant of the fact that it would give a closer grain; he had always thought that it increased the graphite.

MR. J. R. HYDE said there was practically nothing published as to the use of these special elements on cast iron, although they would find volumes about the effect of these elements on steel. He was certainly interested in the phase where Mr. Smalley tackled the production of malleable iron direct from the crucible—he thought they ought to say crucibles, for he gathered that the material was too precious to be put through a cupola. He asked what was the length of the test-pieces on which the bending-angle test was done.

MR. SMALLEY replied that it was 4 in.

MR. HYDE said the ductility recorded was appreciable. He should be glad if Mr. Smalley could tell them anything about the effect of annealing on the bending-angle rather than on the tensile strength. The reference to the introduction of molybdenum was distinctly unique, and they would all be very pleased to hear how the investigation progressed.

MR. SHAW asked Mr. Smalley what size test-bar he had for the 23-ton test. That was also unique.

MR. GREEN, speaking of the T test-pieces, said he expected they were cast as near as possible at the same temperature and similar moulds, and they would naturally expect the same chemical analysis, but he should like to ask if that was so actually. Was the combined carbon the same in those particular pieces? With regard to the chilled test-pieces, he would like to ask whether they were cast directly on to a cast-iron test-block, or was the test-block covered with a layer to protect the test-pieces from the other iron. A surprising feature to him was that the grey-iron and the cylinder-iron showed a similar slight chill, because nearly all cast irons threw out a slight chill.

Molybdenum and Fluidity.

MR. EDGINGTON asked what effect the use of molybdenum had on the fluidity of the iron. When using low phosphorus iron, say 0.2 per cent., would it increase the fluidity or otherwise?

MR. E. ADAMSON (a visitor) said there were several points in which he was in full agreement with the author, one being in regard to the effect of molybdenum. He believed the influence of that element was in the nature of a scavenger more than as a direct influence on the various tests as Mo *per se*. He liked the author's term "grain refining." The molecular structure of iron had not been sufficiently studied in the past, and it was not controlled by chemical analysis. However, he was anticipating going fully into the subject in the near future, and did not propose to introduce it into that discussion. He could confirm the author's opinion that one of the secrets of solid castings was the ability to get all the impurities into solution in the molten metal. He was convinced that in ordinary foundry practice, with certain foundry iron, all impurities did not enter into solution.

Influence of Size on Hardness.

With regard to Brinell, he did not know whether the author had seen work which he (the speaker) had not published in full yet, but which he had shown to a number of friends. On exactly the same iron, from the same ladle, cast into test-bars of $\frac{1}{4}$ in., $\frac{1}{2}$ in., $\frac{3}{4}$ in. and 1 in. he obtained a Brinell hardness, confirmed three different times, of 175 on the 1-in. bar, increasing to 289 and 301 on the $\frac{1}{4}$-in. bar, yet the $\frac{1}{4}$-in. bar, in combined carbon, was 0.37, and the combined carbon in the 1-in. sq. bar was 0.40, showing that the structure of the iron had had everything to do with the large increase in the Brinell hardness. He was glad also that the author had taken into account the influence of the volume of graphite rather than the weight of graphite, because carbon was 12 where iron was 56, which had been generally overlooked when considering the influence of graphite. The growth of graphite had also much to do with the strength of iron. That afternoon his son in carrying out some work had been using pyrometer in a foundry. He (the speaker) had seen high temperatures in some iron foundries with a creamy skin on the surface of the molten metal. The metal examined in his son's work that day had no such skin at all, but had a perfect break, which continued for minutes after it had been cast. That temperature was not as high as some claimed, and he was wondering whether, if the author took his temperature at 1380, the metal had a white, creamy surface or a continuous break, because he was disposed to believe that if there was a creamy surface on the molten metal that the temperature taken on the surface was not that of the metal but the temperature caused by the carbon on the surface of the metal. The pyrometer which his son used was a Cambridge Optical, which was in constant use at one of the big works.

Chromium Cast Iron.

MR. J. F. KAYSER said he did not know if it was fair to call an iron alloy containing $3\frac{1}{2}$ per cent. of carbon a cast iron, but if one might do so he should like to say that he had carried out a large number of tests with an alloy containing about that percentage of carbon, about 1 per cent. of silicon, 0.5 per cent. manganese, and different percentages of chromium the whole way up from 1 per cent. to 20 per cent., and the results, when they got above 7 per cent., were very striking. Not being in a cast-iron foundry, they had no transverse tests, but, as soon as they got above 7 per cent., the effect of the chromium was to give the steel a greater ductility. As cast, they found that when they increased the chromium the casting temperature seemed to have little effect at all upon the properties of the cast material, and there was no difference in the structure, whether it was cast in a chill or in sand. When they reached about 14 per cent. chromium—this was an alloy containing $3\frac{1}{2}$ per cent. carbon, 14 per cent. chromium, and 1 per cent. silicon—they actually had a metal which they could easily soften, which they could readily forge, and which could be again hardened. He knew that ironfounders were very reluctant to add anything at all to their metal. They looked upon it as a cheap metal, and thought it should remain cheap. But he really thought that was a very short-sighted policy. Cast iron was so remarkably cheap that it frequently paid to use an alloy. There were many purposes for which cast-iron was now used which could be better served by the use of a high-carbon alloy containing chromium. Take the case of rolls. The majority of rolls were still made of cast-iron, he thought, but the very highest-class of rolls, which were used for rolling the finest types of rubber, were in every

* These appeared in our issues of December 21, 1922, and January 4, 1923.

case, he believed, made from a chrominum steel; and yearly, or at least monthly, more and more people were turning over to use a chromium alloy in place of a cast iron. He would like to make reference to Mr. Adamson's remarks relating to casting temperature. When steel, or cast iron, or any other alloy, was taken very far above the melting point, they generally found, if they exposed it to the atmosphere, that a scum formed on the top which looked distinctly hotter than the metal underneath. If now the temperature was allowed to fall and the scum was constantly removed, they at last reached a temperature at which for a short time no scum appeared, and then, shortly after that, scum again appeared, which he thought was frozen metal. The temperature of that frozen metal was undoubtedly the temperature of the freezing point of the metal with which they were dealing, and it in every case appeared to be much higher to the optical pyrometer than did the pure molten metal which they could see underneath it. But he thought that that was quite an optical effect altogether. He did not think such high temperatures would be recorded if a thermo-couple was used in the bath.

Aluminium Results Curious.

THE BRANCH-PRESIDENT said he thought Mr. Smalley suggested the reason of the lack of true explanation of these phenomena when he said that they knew very little about the constitution of cast iron. That was to say, before the influence of these special elements was fully understood it would be necessary to investigate their effect on the cementite eutectic and on the separation of graphite in a thoroughly scientific way, just as the influence of those elements on the pearlite eutectic point had already been investigated.

In regard to the effect of aluminium, he agreed with Mr. Shaw that it was a very striking thing that aluminium, which had a pronounced effect on combined carbon in steel, producing graphitic carbon, should reduce the amount of graphitic carbon in cast iron. The result was not entirely abnormal, however, as in the case of the high silicon irons, with 12 to 14 per cent. of silicon, silicon had just the same effect on carbon. In regard to chromium, there seemed little doubt that there was a distinct field of usefulness for it when applied to rolls, both for hot- and cold-rolling—for hot-rolling in the form of cast iron of a special type, and for cold-rolling in a steel mixture. He was particularly interested in Mr. Smalley's remarks about nickel—that a 5 per cent. addition of nickel had very little beneficial effect, whereas 7½ per cent. gave quite promising results—because in steel with a fairly high carbon the reverse was nearer the truth: at any rate a 7½ per cent. nickel steel with high carbon was extremely brittle. Incidentally, it was air hardening.

Mr. Adamson had mentioned Brinell hardness, and in that direction it was useful to note that the relation between tensile strength and Brinell hardness in the case of these cast irons was entirely different from the relation which applied in the case of steel. It was fairly definitely proved that, in the case of steels, one could calculate accurately the tensile strength from Brinell hardness. The factor was not exactly uniform, and required a little variation according to the class of steel, but it was, with any one series, quite a good guide. But where, as here, they got a tensile strength of 10 to 12 tons per square inch with a Brinell hardness of over 200, in the case of steel they would have a tensile strength in the neighbourhood of 45 tons with such a Brinell hardness. It pointed, as Mr. Adamson said, to the fact that the closeness of the grain or physical characteristics of the iron were the governing factors rather than the intrinsic strength of the ground mass as shown by the Brinell hardness. Incidentally, one would imagine that it would require a fairly large-sized ball, with a correspondingly large load, to get a fair index of the true Brinell hardness.

Dr. Swinden on Effect of Molybdemun.

He hardly dare refer to molybdenum, because he thought of nothing else, hardly, for about four years. But he was extremely gratified to find, throughout Mr. Smalley's experiments, confirmation of the essential point of his (Dr. Swinden's) investigation. His work was on the effect of molybdenum on steel in its various properties, and the result of the whole of that work was that he was unable to find any evidence whatever that molybdenum formed a double carbide. Mr. Smalley, he thought, in opening his lecture, said it did, but he (the speaker) did not think his results confirmed that. The fact that the addition of molybdenum tended to reduce rather than increase the proportion of combined carbon was distinctly against that view. The suggestion which he (Dr. Swinden) put forward in regard to steel was that molybdenum existed in the form of an iron-molybdenum compound, which was in solution in the iron, but which probably was in the form of a colloidal solution. He could imagine some little perplexity in understanding that, but he thought the time was coming when one would have to regard solutions in metals not only as simple solutions similar to the ordinary crystalline solutions, but also as colloidal solutions. He thought that evidence was pointing very distinctly in that direction. With reference to molydenum acting as a scavenger, he had no direct experimental evidence on that, but it was quite a resonable expectation, particularly since molybdenum existed in Nature as a sulphide (molybdenite). He was rather puzzled at first to know why Mr. Smalley had selected molybdenum, which was a comparative expensive alloy, to test its effect on cast iron. There seemed to be so many other better known special elements, so to speak, that had possibilities, without going into the possibilities of molybdenum, which, generally speaking, was used in tool steels to replace tungsten, with an entirely different object. True, it had been pushed a good deal in recent years as a constituent of structural steels for automobile and aircraft purposes, but it had not been developed, in this country at any rate, as it was in America, as a structural steel to any very serious extent, as compared with nickel, chromium and vanadium. One found, however, that the selection of molybdenum was quite a happy one, as Mr. Smalley explained, to have both the softening effect of nickel and the hardening effect of chromium in one alloy. It had never appealed to him quite in that way, but the results certainly tended to support the author's view that his prediction was correct. The point about pyrometric work was very important. Mr. Kayser had suggested the correct explanation, which was that the emissivity of iron oxide was much higher than that of iron, hence they obtained a higher reading on the pyrometer for the same actual temperature.

THE AUTHOR'S REPLY.

MR. SMALLEY, in reply to the discussion, said, in answer to Mr. Shaw, that the tensile test-bars used were 1¼ in. dia. and were machined to 0.798 in. dia.

Mr. Hyde had made some comments in reference to the bending tests and the effect of annealing. In some of these alloys, particularly where one encountered new properties, such as with the aluminium and with nickel and copper in combination, and particularly with the chromium series, the effect of annealing was closely investigated. In no instance, however, did it prove beneficial to the ductility, whilst commercial annealing failed to produce graphite in the chromium series containing 0.75 per cent. chromium.

Mr. Green referred to the T test-bars and the temperature of the mould. Throughout the experiments the importance of control of the rate of cooling was observed, and precautions were taken to have both the temperature of the mould and the dimensions constant throughout. The temperature of the moulds was controlled at 100 deg. F. With regard to Mr. Green's comments on the change of the chemical analysis of these sections after casting, his prediction was quite right. The change is shown in the Paper, *e.g.*, in the molybdenum cast, the sulphur content was reduced, whilst the total carbon content came out low. Throughout the research, however, casting conditions were as near similar as possible. The metal was run direct from the cupola into the big ladle, and then the contents of that ladle was distributed into six small ladles introducing each of the special elements as outlined in the Paper. With regard to the variations in the chemical composition, they in themselves were the factors that

produced the structural change, because what he was investigating at the time was chemical composition as a grain refiner, eliminating every other variable as far as possible. Of course, one could advantageously discuss mass effect in conjunction with these experiments, which he thought was in itself even more important than the effect of chemical composition as the single variable.

Brinell Test Limitations.

With regard to the preparation of the chill test moulds, the chill was specially prepared by a laboratory assistant. He was told off to clean the bars, and polish each with dry plumbago at a temperature of about 300 deg. F. The plumbago was thus well rubbed in, and only a film remained such as to prevent seizing without causing heat insulating film. The temperature of the mould was controlled at 100 deg. F. Each was cast under identical conditions.

With regard to the value of Brinell figures, this test on cast iron, after all, is of limited value. Personally, he did not regard cast iron as a structural material from the same point as steel, and the same physical tests should not be used. The chief value of cast iron is that of a bearing metal; and rigidity, solidity and lubrication are the properties which must be tested for. He questioned the value of the tensile, and he also doubted whether the average foundrymen even knew what a transverse test meant. Personally, so far as the strength of cast iron is concerned, he thought of it in terms of solidity. The engineer measured solidity by calling for a hydraulic test, and, after all, cast iron is a porous metal, and the closeness of the pores largely determines its useful value as a casting, and should be expressed in terms of degree of solidity.

In answer to Mr. Edgington, so far as he could tell, molybdenum did not affect the fluidity. In the cylinder irons the fact that he found molybdenum to close the grain led him to make experiments as to whether this metal would counterbalance the liquation effects of the phosphide, because phosphorus was of particular value in cast iron in giving clean metal and allowing it to flow well, but he found that molybdenum did not assist to the extent anticipated and counteract the drawing common to high phosphorus irons.

Mr. Edgington also asked a question with regard to the value of molybdenum in an iron containing 1.20 per cent. silicon and 0.2 per cent. phosphorus. He (the speaker) would not recommend using a molybdenum in such an iron. There was no real object in doing so. The troubles with a low silicon iron of low phosphorus content cupola melted were enough in themselves without introducing more complications in the form of a special metal. If he were to choose an iron for the manufacture of an article exhibiting marked changes in section and one that must also flow well, he would always choose a low phosphorus iron, but would increase the silicon, keeping the total carbon between 3 and 3.2 per cent. and cast hot. For instance, in those solidity bars which he had shown with the 1.2 per cent. silicon, 0.2 per cent. phosphorus iron, one invariably got perfect solidity, but if cast with 1.2 per cent. silicon and 0.9 per cent. phosphorus they invariably got a draw hole. If they cast with 1.7 per cent. silicon with 3.2 per cent. carbon and kept the phosphorus down below 0.20, the draw was eliminated, thus enabling the casting of complicated sections with a fluid iron without the use of chills.

Utility of Optical Pyrometers Doubled.

Mr. Adamson's remarks on mass effect and Brinell hardness confirmed the speaker's. He had obtained results similar to those that Mr. Adamson mentioned. With regard to the temperature of cast iron in the ladle at 1,495 deg. C. and the appearance of a creamy surface, he (Mr. Smalley) had investigated both the radiation and the optical pyrometer in the foundry, and had condemned them. Mr. Adamson's temperature was probably obtained by an optical pyrometer, but not under black body conditions.

The pyrometer he always used was a thermo-couple. The temperature of the cast iron in their foundries was measured every day with this thermo-couple. It was dipped into the molten iron to a depth of 6 in., and the readings were accurate to 5 deg. C. The first cost of a thermo-couple was high—approximately £52—but he had had one in operation in one foundry now for two years, and the platinum was worth what he gave for it. The highest temperature he had ever measured of cast iron in the ladle was 1,420 deg. C. He was speaking now of true temperatures. If there was a temperature above 1,380 deg. C. it gave a glaring iron which fumed. The creamy surface, to which Mr. Adamson referred, he had always found to be associated with a temperature above 1,350 deg. C., although it is not purely a temperature effect. With regard to temperature control, he had found that the practical man could control his temperature very well by eye, providing he knew his metal, but metal from a cupola was apt to vary very much in chemical composition, and if one judged the temperature by eye, say, for example, an iron that was fairly high in silicon, and high in phosphorus, and used that same temperature for a cylinder iron, one was apt to produce very bad effects from the point of view of shrinkage, because shrinkage of cast iron, *i.e.*, liquid shrinkage, was more an effect of temperature than of composition.

Acid Resisting Irons.

He was very interested to hear what Mr. Kayser had to say, and he hoped that gentleman would publish his results, because he thought the possibilities of chromium in the proportions that he gave appeared exceedingly useful, and would at least give a basis for future experiments. The 15 per cent. silicon alloy, *e.g.*, had been proved of particular value for chemical purposes, and he thought the chromium series also presented similar commercial possibilities. Again, there are great possibilities for the manufacture of non-growing irons for annealing pots and pans, stirrer blades, firebars and the like, *e.g.*, a nickel chrome iron containing 2.7 per cent. C, 1 per cent. Cr, and 6 per cent. Ni was supplied to substitute 13 per cent. chromium steel for firebars. Those firebars were to work in a temperature of 900 deg. C. They stood up very well, and did not readily oxidise, at least they gave a satisfactory life before they broke down, and he thought there were possibilities for the special irons for purposes like that if their value was proved.

How Molybdenum Exists.

Dr. Swinden had mentioned the relative effect of 5 and 7½ per cent. of nickel. In conducting the experiments on the production of malleable cast iron direct from cupola, he merely conducted what he called exploratory experiments, to ascertain the best lines of attacking this problem. He had given them the results of these tests. They were, after all, but feelers in a vast subject, and must be regarded in that light. His Brinell hardness tests were made with a 10 m.m. ball and 3,000 kilogrammes pressure, and in each case the load was retained 45 seconds. In regard to Dr. Swinden's remarks on the constitution of the carbide of molybdenum, Dr. Swinden is the leading authority on this work, and his (the author's) quotations on the double carbide in steel were not from his own work. Dr. Swinden was probably right in what he said. Dr. Swinden's last remark as to considering the solution of the metals from the colloidal dispersion theory was exceedingly interesting to him. That was the point of view that he had always taken in investigating the effect of any element on another metal. It was full of complexities, but he thought that the possibility of a better understanding of the function of graphite in cast iron, or the function of any other element, lay in a clearer interpretation of the nature of the solutions of metals.

Dr. Swinden, in conveying the thanks of the members to Mr. Smalley, said the work of which they had heard that night was pioneer work, but he felt that the application of special elements to iron would, in not so many years, be as commonplace as it was to-day in the case of steel.

Acetylene and Oxy-Acetylene Welding.—The Factory Department, Home Office, have issued a Memorandum on Dangers from the Use of Acetylene Gas and in Oxy-Acetylene Welding in Factories (Form 1704).

Aluminium-Silicon Alloys.

Mons. de Fleury, in a Paper on Alpax, before the French Foundrymen's Association, which we published in our issue of October 12, gave some details of the possibilities of 13 per cent. silicon 87 per cent. aluminium alloy. More light is thrown on this subject in an article on the "Properties of Aluminium-Silicon Alloys," by J. D. Edwards, of the Aluminium Company of America, in a recent issue of "Chemical and Metallurgical Engineering," of which the following is an abstract:—

Aluminium-silicon alloys may be grouped in two classes. What may be called the "normal alloys" are made by melting silicon (or a rich alloy of silicon and aluminium) with aluminium, and casting in sand according to the usual foundry practice for aluminium alloys, except that in most cases all chills may be omitted. They are characterised by a relatively coarse crystalline fracture, especially when the silicon is high. When the iron content is also high, excessively coarse-grained structures are produced. When polished and viewed under the microscope, they reveal the presence of silicon as relatively large plates and needles in a matrix of aluminium.

What are known as the "modified alloys" are given a special treatment in the molten state immediately before casting. The Aluminium Company of America's process of modifying aluminium-silicon alloys consists in the addition of very small amounts of metallic sodium to the molten alloy a short time before casting. The modified alloy exhibits an exceedingly fine-grained fracture; the microscope shows the silicon to be present as very finely-dispersed particles; the silicon particles are sometimes so small as to be resolvable with difficulty, even at very high magnifications.

The modified alloy largely reverts to the normal alloy on re-melting, so that to secure a completely modified alloy, the molten metal must usually be re-treated each time before casting.

The aluminium-silicon alloys possess a combination of desirable properties which fit them for many uses, especially for the production of difficult castings, involving both thick and thin sections. Some of their most useful characteristics fall under the term of "casting properties." They flow readily, may be cast into very thin sections without cracking, and are quite free from shrinks and the porosity which is not uncommon in some other aluminium alloys, so that they are "watertight." These same good casting properties are found in both the normal and modified alloys, so that the use of the modified alloy is, in general, only indicated where its increased strength and ductility will prove advantageous. The proportion of silicon to be used in any alloy will depend on its particular application. In general, a somewhat higher proportion of silicon can be used in the modified alloy than in the normal alloy. This is due to the fact that the process of modification raises the apparent eutectic composition considerably above its normal figure (11.5 per cent. silicon), and changes what would have been relatively large particles of excess silicon (in alloys containing over 11.5 per cent. silicon) to very finely-dispersed particles of eutectic silicon.

The modified alloys should contain from about 8 to 15 per cent. silicon; 12 per cent. silicon makes a good alloy. The normal alloys may contain from 4 to 10 per cent. silicon; 5 per cent. silicon has been found to make a very satisfactory alloy for sand castings.

In the following paragraphs will be found values for a number of the physical properties of aluminium-silicon alloys, which are pertinent to their commercial application.

Density.

Silicon is lighter than aluminium; its density is about 2.4, as compared with 2.7 for aluminium. The alloys have densities intermediate between these two values. The 10 per cent. silicon alloy will have a density of approximately 2.65 grams per c.c. There is a tendency for the modified alloys to be slightly lower in density than the normal alloy, but the difference is not significant. The 10 per cent. silicon alloy is 7 to 8 per cent. lower in density than No. 12 alloy (8 per cent. copper), and weighs approximately 166 lbs. per cub. ft.

Expansivity.

The splendid casting qualities of the aluminium-silicon alloys are in part the result of their relatively low shrinkage. The pattern shrinkage is the same as for other aluminium alloys, namely, $\frac{5}{32}$ (0.156) in. per foot. The aluminium-silicon alloys have a very much smaller crystallisation shrinkage than either No. 12 alloy or pure aluminium. Pure aluminium contracts between 6 and 7 per cent. in volume on solidifying; this contraction in volume results in the formation of a cavity or pipe. This crystallisation shrinkage or contraction is reduced to 4 per cent. or lower in the 12 per cent. silicon alloy. The thermal expansivity of the 10 per cent. silicon alloy is about 0.000012 per deg. C., in the range 20 to 100 deg. C.

Tensile Strength and Elongation.

The modified alloy has considerably greater strength and ductility than the normal alloy. Typical results for various alloys are given in Table I.

TABLE I.—*Strength of Aluminium-Silicon Alloys as cast in Green Sand.*

Composition	Character of Alloy	Tensile Strength, Tons Sq. In.	Elongation, Per cent. in 2 in.
Silicon 5%	Normal	8.0	5–6
Silicon 8%	Normal	8.4	4
Silicon 8%	Modified	10.9	12
Silicon 13%	Normal	10.9	2
Silicon 13%	Modified	12.5	8

Better or poorer results than the above can be obtained with varying conditions. The proportion of iron in the alloy should be strictly limited for the best result. Iron forms with silicon an iron silicide, which appears as needles in the microstructure. The modifying treatment has little refining effect on the particle size of this constituent, and its presence tends to reduce the ductility. The alloy as cast should preferably contain not over 0.5 to 0.6 per cent. iron. The copper content of the modified alloy should also be held below about 0.8 per cent. if the highest combination of strength and ductility is desired.

Machining Qualities.

The aluminium-silicon alloys are not quite so easily machined as No. 12 alloy. They exhibit a very pronounced tendency to drag under the tool. Particles of excess silicon, if present, add greatly to the difficulty of machining or polishing, as they tear out readily, and are exceedingly hard and scratch the soft aluminium readily. Normal alloys containing less than about 11.5 per cent. silicon will contain no excess silicon. Above this proportion they may contain excess silicon unless completely modified.

Production of Castings in the Foundry.

For the preparation of the alloy, the rich silicon alloy supplied by the Aluminium Company of America is desirable on account of its method of manufacture. This alloy contains approximately 20 per cent. silicon, has a melting range of about 577 to 700 deg. C., and dissolves readily in aluminium at temperatures not over 700 deg. C.

Process of Modification.

The Aluminium Company of America's process of producing modified alloy castings consists in adding to the aluminium-silicon alloy a very small percentage of metallic sodium. The correct amount of sodium to treat a definite weight of aluminium-silicon alloy is supplied in a sealed aluminium capsule. The aluminium-silicon alloy is heated to a temperature of about 815 deg. C., and the proper number of aluminium capsules placed in a phosphoriser, which is plunged to the bottom of the crucible. The phosphoriser, so called, is an inverted cup, formed from a graphite crucible or a short piece of iron pipe and held on the end of an iron rod; the iron parts are coated with graphite or lime wash to prevent attack by the aluminium. The aluminium capsules are wedged into the in-

verted cup, and melt when plunged into the molten alloy. The melted sodium then escapes slowly into the alloy through a series of small holes in the sides of the cup near its top. The sodium diffuses through the metal, and a certain amount rises to the surface and burns. The liquid alloy should be kept up to a relatively high temperature until all the sodium has disappeared from the phosphoriser. The operator can tell when all the sodium has dissolved by lifting the phosphoriser until it comes in contact with the air. If there is no sodium flame, the modifying process is complete. When the modifying operation has thus been completed, the metal is skimmed. Stirring is not advisable, as it facilitates the oxidation and loss of the contained sodium. Skimming, however, should be performed with great care. When the metal has reached the proper pouring temperature, it can be cast in the usual way. As low a pouring temperature as possible should be employed. Too long a period should not intervene between the time of treatment and the time of pouring, if complete modification is desired. The metallic sodium is lighter than aluminium, and relatively insoluble in it, so that it is gradually lost from the molten metal on standing. The modified alloy exists in a potential form only, in the liquid state; the actual modification results from the modified mechanism of solidification in the presence of the sodium.

Contracts Open !

The following correspondence between one of our readers and an American firm discloses an inquiry which some of our slack foundries may care to tackle:—

The ——— ——— Company,
Steel and Iron Work,
San ———, Texas.
June 14, 1922.

To the ——— ——— Company, Limited,
Dunston-on-Tyne, England.

GENTLEMEN,—We are endeavouring to find a steel for making jails that is hard enough to resist cutting tools, ductile enough to prevent the prisoners breaking it, and practically non-annealable after once being tempered or hardened.

We are familiar with, and have been using, the regular chrome or laminated steel bars, sometimes called five- or seven-ply steel, which is made up in alternate layers of soft and hard steel, the soft layers being ordinary open-hearth or Bessemer steel and the hard layers being a high-carbon steel which will harden very hard. This steel is manufactured by several companies in the United States, and has been satisfactory except that after it is hardened, assembled, and erected in the jail cells it can be softened by application of heat to such an extent that the hard layers can be cut. What we want is a steel made in similar form to this, or in solid bars, having the quality of self-hardening—that is, that will harden in the atmosphere to its original hardness after the heat is removed. Prisoners sometimes secure some means of heating the bars and drawing the temper to such an extent that the bars can readily be cut, and it is our desire to secure a steel which, when the heat is removed and it cools off in the natural air, will still be hard.

The regular self-hardening tool steels meet these conditions except that the solid bar is so hard it can be broken, and is too expensive to use in jail construction. If the ordinary chrome or laminated bars could be made up with the hard layers of this non-annealable or self-hardening steel, we think they would be satisfactory, and owing to the fact that the percentage of hardened material in the laminated bars is small, the cost of them need not be prohibitive.

We use rectangular bars $\frac{1}{2}$ in. thick by 3 in. wide, and round bars $1\frac{1}{8}$ in. in diameter.

If you are now manufacturing, or can manufacture a bar of this kind, we would thank you to give us a complete description of it, and the approximate cost per lb. delivered in carload quantities f.o.b. cars Galverston, Texas, U.S.A.

In the event you do not or cannot manufacture such a bar, will you kindly put us in communication with someone who does manufacture it, or with someone who you think would manufacture it?—Yours very truly,

——— ——— COMPANY.
By —. —. ———,
Secretary.

June 30, 1922.

Messrs. The ——— ——— Company,
Steel and Iron Works,
———, ———, Texas.

DEAR SIRS,—We are obliged for your interesting letter on steels for cages for jailbirds.

It would appear that your choice cracksmen come mostly from among the steel heat-treatment experts. If this is so, we fear there is no steel made in the "Old Country" which can give them more than fifty-five minutes' mental thought and five minutes' laborious trouble.

The suggestion you make of using a non-annealable steel is one which a great friend of ours, Mr. William Sikes, thinks excellent. He says the liberation of the annealing furnaces would permit of the same being used for a warm welcome for Sing-Sing guests, with a Georgian negro to do the stoking.

However, we are most desirous of helping Uncle Sam in distress, and would suggest he should visit our State hotels over here and see some of our ex-Presidents, ex-District Attorneys, and ex-Oil Kings at work hopelessly knocking their heads (and blow-lamps) against the ramparts of the Tower of London. They never succeed in getting out, and can be seen regularly every morning at breakfast with the Boss-Jailor.

Don't be too downhearted about the job. The fruits of good education to all and sundry must have a safety valve, and if, as you suggest, self-hardening tool steel is expensive for the jails, think of the advantage of the State of successfully retaining, by its use the services of really good steel technologists who have strayed into the path of unrighteousness.

Other ways of retaining the flock might consist of not supplying them with matches, which they might use for annealing, or of giving them more tobacco than the allowance of lucifers will satisfy. —Yours sympathetically,

THE ——— ——— COMPANY.
Per ——— ———

P.S.—By the by, have you tried manganese steel? They tell us most of your steel experts don't know its heat-treatment. Keep it quiet, and you will gather in the whole of the Steel Corporation and most of the independents!

Publication Received.

THE CLAY CROSS COMPANY, LIMITED, Clay Cross, near Chesterfield.—This firm are sending to their clientele a diary which contains a fund of information useful alike to the engineer and foundryman.

Iron Production in Brazil.—According to a report (just published) by the Commercial Secretary to the British Embassy at Rio de Janeiro, in which reference is made to iron and steel development in Brazil, the Usina Esperança produced 9,990 tons of pig-iron, and the Usina Miguel Burnier a daily average of 12.5 tons in 1921. The installation at Ribeirao Preto is nearing completion. The Federal Government at the end of 1921 made a contract with the Anglo-Brazilian Iron and Steel Syndicate, Limited, giving powers and concessions, under the siderurgical law of 1918, to the Syndicate, who, however, were not able to start operations immediately, pending further negotiations with the Federal Government in regard to the acquisition of hydro-electric power for the proposed iron and steel works. These negotiations will, it is expected, soon be completed. There is little doubt that the Brazilian Government is disposed to give every protection to the iron and steel industry in their country.

Trade Talk.

THE UNITED BRASSFOUNDERS AND ENGINEERS, LIMITED, have changed their head office from Manchester to Ormskirk.

TWO OF THE FURNACES of the Bestwood Coal & Iron Company, Limited, which were damped down in April, 1921, are to be relighted shortly.

MR. WM. MATTHEWS, civil engineer, has removed from 39, Victoria Street, Westminster, London, S.W.1, to 58, Westwood Road, Southampton.

THE WAGES of craftsmen in the West Wales steel, tinplate and engineering works and foundries were reduced by six shillings a week as from January 1.

THE EMPLOYES of T. W. Ward, Limited, of Sheffield, may in future subscribe to more than 1,000 shares in the company, their interest being limited to that number hitherto.

CONSETT steel plate prices for September, October, and November, having been officially returned at £9 10s. 8.96d. per ton, there will be no immediate change in the wages of the workers.

SANDERS, BROS. & COMPANY, LIMITED, metal merchants and agents, have closed their office at 10, Bush Lane. Their London business will in future be carried on solely at 139, Fenchurch Street, E.C.

THE TELEGRAPHIC ADDRESS of the London office of Thos. Firth & Sons, Limited, Norfolk Works, Savile Street East, Sheffield, at 8, The Sanctuary, S.W.1, has been changed from "Mesmeric, Vic." to "Mesmeric, Parl."

THE HEAD OFFICE of F. N. Pickett et Fils, Wimereux, has been transferred to Dannes-Camiers, par Neufchatel, Pas-de-Calais. Questions relating to sales will in future be conducted from Hangar "R," Bassin Loubet, Boulogne-sur-Mer.

THE DIRECTORS of the National Boiler and General Insurance Company, Limited, have notified the shareholders not to part with their shares, as the company is about to complete negotiations for its absorption in one of the big insurance companies.

J. BLAKEBOROUGH & SONS, LIMITED, of London and Brighouse, have recently received instructions to supply all the valves and circulating pipes required in connection with the electrification of the Glencoe-Pietermaritzburg section of the South African Railways.

THE BUSINESS of Lionel Dektereff, engineers and general merchants, 118, Queen Victoria Street, E.C.4, will in future be carried on as Dektereff, Francke, & Reppman, Mr. Dektereff having entered into partnership with Mr. Victor Francke and Mr. Albert Reppman.

RETURNS from the Clyde shipyards show that during last year vessels aggregating 390,000 tons were launched and that machinery constructed was equivalent to 357,000 indicated horse-power, as compared with 514,000 tons gross and 478,000 indicated horse-power last year.

MR. M. BOWLEY, metal broker, of 21, Cullum Street, London, E.C.3, has amalgamated his business with the similar one carried on by his son under the style of Malcolm C. S. Bowley & Company, which firm now ceases to exist. The joint concern will be known as Malcolm Bowley & Son.

IN VIEW of the wide range of products of special interest to collieries, iron and steel works, cement works, quarries, etc., manufactured by Vickers, Limited, and their associated companies, a new branch office has been opened at Principality Buildings, Queen Street, Cardiff. Mr. H. Thackeray is manager of this branch office.

A CIRCULAR has been issued by the National Federated Electrical Association to its members notifying a variation of wages in the electrical contracting industry in accordance with the National Wages Agreements entered into by the Association and the Electrical Trades Union and with an agreed recommendation by the two bodies at York on July 27. It is notified that the rates of all grades will be reduced by a further 5 per cent. on the April, 1921, rates, making a total reduction of 32 per cent. on the April, 1921, rates to come into effect on the first pay day following Sunday, January 7, 1923, for the period covered by that pay day.

THE CRANE DEPARTMENT of Sir William Arrol & Company, Limited, have recently taken contracts for one 90-ton overhead traveller, four 1½-ton, four 2-ton and four 3½-ton fixed jib cranes, one 3½-ton overhead electric traveller (all for Brazil); one 60-ton and two 5-ton overhead electric travellers, and two 100-ton electric traversers (all for Brazil); one 60-ton "Temperley" bridge transporter with grab for coal handling at Portsmouth, and several overhead electric cranes of 30-tons, 10-tons, and 5-tons power. The South Indian Railway Company have placed the order for the steelwork for their new shops at Trichinoply with Sir Wm. Arrol & Company, Limited.

THE DIRECTORS of Sheffield Steel Products (Stores), Limited, have put before the preference shareholders the situation that has arisen as a result of the appointment of a receiver of Sheffield Steel Products, Limited. Although the accounts of the former firm for the current year are not yet ready, the directors are satisfied that the trading results will not permit of the payment of the preference dividend without the aid of Sheffield Steel Products, Limited. During the last few weeks the directors have been in negotiation with the receiver and manager of Sheffield Steel Products, Limited, with a view to his paying the January dividend under the guarantee by that company, but should such negotiations result in an agreement the receiver cannot conclude same without the authority of the Court.

Company News.

Prince of Wales Dry Dock Company (Swansea), Limited.—Interim dividend, 7½ per cent. (actual), less tax.

Tinsley Rolling Mills, Limited.—Preference dividends postponed until accounts for current financial year made up.

Allen-Liversidge, Limited.—Final dividend, 9 per cent. per annum, less tax, a total distribution of 8 per cent. for year.

Metals and Accessories, Limited.—Capital £5,000 in £1 shares. Directors: D. W. Jones, J. C. Davis and D. H. Davis.

B.M.S. and M.P. Company, Limited, 1, Gosta Green, Birmingham. Capital £300. Iron, steel and metal merchants, etc. Directors: A. C. Lloyd and J. Grant.

Fred Wheelwright & Sons, Limited.—Capital £1,000. Metal merchants. Directors: F. Wheelwright, J. G. F. Wheelwright and F. A. Wheelwright. Secretary: J. G. F. Wheelwright.

Drakes, Limited.—Profits, £11,090; brought forward, £10,567; available for disposal, £21,657; ordinary dividend, 10 per cent., free of tax; reserve, £10,000; carried forward, £3,707.

Charles Shaw (Birmingham), Limited, Moland Street, Birmingham.—Capital £1,000 in £1 shares, to take over the business of a metal merchant and caster, carried on by C. Shaw.

George Wood & Company (Engineers), Limited, 12, St. James Street, Sheffield.—Capital £5,000 in £1 shares. Directors: G. L. Wye, J. Mitchell and G. Wood. Secretary: G. E. Tash.

Heavitree Engineering Company, Limited, Alphington Road, Exeter.—Capital £1,000 in 2,000 shares of 10s. each. Directors: V. A. Pickney, E. S. Hutt (managing directors) and J. Lake.

Blake's Patents, Limited, 36, Camomile Street, London, E.C.—Capital £600. Mechanical, consulting and experimental engineers, etc. Directors: G. Blake (chairman and managing director), W. Hyde and E. Burger.

McCall & Company (Sheffield), Limited, 1, Cambridge Arcade, Sheffield.—Capital £2,000 in £1 shares, to acquire the business of a steel merchant carried on by T. H. McCall as Downton McCall & Company, Permanent directors: T. H. McCall, E. L. Raworth and C. W. Hamilton. Secretary: C. W. Hamilton.

Baldwins, Limited.—Balance of manufacturing and trading account, £306,132; depreciation, £50,000; sinking fund premiums, £11,357; debenture stock interest, £157,781; dividend on 5½ per cent. preference shares, £13,750; dividend on 5 per cent. "B" preference shares, £67,544; brought forward, £303,479; carried forward, £309,178; no ordinary dividend.

John Needham & Sons (Manchester), Limited, 15, Cross Street, Manchester.—Capital £60,000 in £1 shares, to acquire the business of iron and steel merchants and manufacturers carried on by Sir Christopher T. Needham and Colonel J. G. Needham as John Needham & Sons. Permanent directors: Sir Christopher T. Needham and Colonel J. G. Needham.

Large Blast Furnace in India.—What is reported to be the largest blast furnace in Asia was set in operation recently at the Hirapur works of the Indian Iron & Steel Company, Limited, Asansol. Mr. G. H. Fairhurst (managing director of the Company) gave a brief description of the works, stating that the furnace was designed to turn out 400 tons of pig-iron per day. To reach this output, a total of 1,600 tons of material and products would have to be handled daily. It was also stated that the Company's first by-product coking plant was now operating successfully, involving the daily handling of a further 1,800 tons of material and products, and that in the first few months of 1923 the capacity figures would be doubled with the putting into operation of the second coke-oven battery and the second blast furnace.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The Cleveland iron market has now settled down to actual business after the holiday vacation, with, it is satisfactory to note, a much more encouraging outlook than had been regarded as probable a short time ago. This improvement in conditions is evidenced by the steady expansion of home consumption, as confirmed by the recent buying movement among the foundries, while an increasing demand is also experienced for steel-making iron, with consequent advantage to hematite producers. Inquiries are now coming forward in increasing volume both for prompt and forward deliveries, the latter affording convincing evidence of returning confidence among consumers that nothing is to be gained by further delaying contracts for supplies over the quarter's end. In support of this view it may be pointed out that fuel costs are mounting up, and with supplies scarce prices are more likely to go higher. Unfortunately, the export trade still languishes, and Continental business is only very moderate and spasmodic, being hampered by the currency difficulties. Turning to prices, the improvement in the home demand has created conditions of scarcity for the leading lines. Current quotations may be taken as follows:—No. 1, 96s. 6d.; No. 3 G.M.B., 92s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 82s. 6d.

The Tees-side hematite market begins the year with a healthy tone, large orders having been booked both for Sheffield and South Wales, and makers are well sold for some weeks ahead. There has been but little doing over the holiday period, but the flow of inquiry is recommencing, and, with the undoubted revival of shipbuilding, there is a very confident feeling. Quotations are strongly held, East Coast mixed numbers being firm at 93s. 6d., and No. 1, 94s. per ton. The export trade is still the least satisfactory side, and till financial conditions are more settled on the Continent there can be no great hope of substantial improvement.

MANCHESTER.—The markets here for foundry pig-iron now show more promise of active business than has been the case for some time. The ironfounders of the district are much better off for orders than they were, and the demand is not now so exclusively for special textile machinery castings. The trade in builders' castings is still comparatively small, but it may be hoped that this section of the ironfoundry trade will improve, for it is clear that something must now be done to facilitate the building of houses. The consumption of foundry pig-iron is evidently going to be larger, but this does not necessarily involve higher prices for pig-iron. It will, however, mean a larger production, and more furnaces are already being put into blast. The appearance of North Lincolnshire foundry pig on this market, after an absence of nearly two years, is a feature which calls for some satisfaction; and probably there will not be so much of it as to weaken prices in the district. Derbyshire No. 3 is still quoted here at 90s. per ton delivered, but some sellers are trying for 91s. for small lots and for prompt delivery.

SCOTLAND.—Work on Clydeside has only been partially renewed so far, but the tone of the market continues firm and steady, smelters evidencing little disposition to sell at current quotations. The price to-day is, in their opinion, too low, and they expect that a more remunerative figure will be obtainable by waiting. Meantime the buying movement is still in evidence, and the interest in forward iron is maintained. No. 3 Scotch is quoted at 95s. at furnace and £5 f.a.s. Glasgow. There was a better business done with America last week, and other markets are stronger in their demands.

THE MIDLANDS.—Consumers of pig-iron in this area have so far confined their attention to purchases on a restricted scale, probably in view of this week's quarterly meeting, when some definite pronouncement on the question of prices is anticipated, although little hope can be entertained of any lowering of quotations. In the meantime, the demand for foundry iron is well maintained, but at present is hardly sufficiently developed to encourage any considerable extension of output capacity. As previously reported, the qualities chiefly in demand are Derbyshire and Northamptonshire makes, very little South Staffordshire pig now coming into the market.

Finished Iron.

The quietly steady improvement marked in the finished iron trade at the close of the year continues, makers' order books being in a much more satisfactory condition than for some time past, while the placing of many important contracts for engineering and shipbuilding also furnish encouraging signs of future expansion of demand for this class of material. The chief obstacle to progress in this much-to-be-desired direction is, however, the present high scale of costs in all branches of production, notoriously in the exorbitant charges for rail transport and the equally oppressive charges for manufacturing fuels. Until these difficulties can be surmounted an early return to more prosperous conditions in the industry is out of the question. Meanwhile it is satisfactory to note an improvement in the export returns, the shipments of manufactured iron and steel from Middlesbrough in December having amounted to 44,913 tons, as against 35,932 tons in November, an increase of 8,981 tons. The total shipments during 1922 amounted to 450,115 tons, as compared with 326,181 tons in 1921. Last year's total is the highest since 1915. It included 175,000 tons to India and Ceylon, and nearly 50,000 tons to Australia and New Zealand. Pending this week's quarterly meeting at Birmingham, quotations remain undisturbed at the figures previously given, to be found on another page of the JOURNAL. The South Yorkshire Bar Iron Association have advanced their prices for bar iron by 10s. per ton, the basis price for crown bars now being £11 10s. per ton net delivered.

Steel.

Stocktaking now having been completed, work has been generally resumed in the various branches of the steel industry, in which the year opens with a buoyant feeling that the long overdue revival of trade has at length arrived. Demand all round, with few exceptions, is on a distinctly more active scale, the market for semi-products, especially basic billets, showing steady improvement, while acid material is making a better showing, and is likely to expand satisfactorily before long. More Sheffield furnaces are going into operation, and very shortly the production of raw steel will be well ahead of the pre-war average. The effect of the placing of the contracts for the two new battleships is already being felt in various branches of the local steel industry. Orders for steel are coming to hand in encouraging fashion, and even from abroad some business is being received for the more expensive makes of steel. Tool steel is more freely asked for, while motor steel is very active. In the market for alloys business in ferro-manganese for home account fluctuates, but is very firm on the whole, with prices remaining firm at £15 for loose and £1 extra for packed. For the export trade, however, no doubt due to the falling off in the Continental and American demand, the makers have reduced their prices by 10s. per ton, making the present price £14. The tone of the tinplate market is quite good and prices rule very firm. The official minimum selling figures are unchanged, but most works are now quoting at least 3d. a box higher. There has been a very fair all-round inquiry of late, and a good deal of steady buying is reported. Quotations for the basis sizes are very firm at 20s. to 20s. 6d. per box for IC 14 by 20, 112 sheets, 108 lbs., and 20s. 6d. to 21s. per box for IC 28 by 20, 56 sheets, 108 lbs., in coke finish, with usual options, net cash, f.o.b. Bristol Channel.

Scrap.

Reports as to the conditions prevailing in most centres of the scrap metal trade continue favourable, and now that consumption has been resumed on an active scale, prices for steel and iron material show a distinctly stiffening tendency. In Scotland all qualities of steel and wrought-iron scrap are difficult to secure, and there are no signs of the supplies being augmented. As a matter of fact, until it is possible to bring in materials from outside sources, either by increasing local prices or the reduction in values of scrap which can be offered for delivery in this district, the shortage will continue and affect market conditions considerably. A number of the shipyards and engineering works are now much better off for orders and this should mean more orders for the iron and steel works, while the demand for scrap should increase proportionately. The foundries also seem to be in an improved position, and inquiries for cast-iron scrap are much more numerous than has been the case for many months past, and prospects of an increased demand in this direction are also brighter. On the North-East Coast there are indications of an early advance in prices for heavy steel scrap. This also applies to steel turnings and cast-iron borings, which are at the moment round about 55s., delivered works. With the better shipbuilding outlook the foundries are getting busier, which means a heavier demand for cast-iron, and prices are expected to advance. The present figures for machinery quality in handy pieces

is 75s. to 77s. 6d. per ton, delivered works. Heavy wrought-iron piling scrap is certainly stiffening, the present figure being about 72s. 6d., delivered works. Special heavy forge is also showing an upward tendency at 82s. 6d., delivered works.

Metals.

Copper.—The market for standard copper has fairly maintained the strong position noted in recent reports, values fluctuating within a limited range, and generally inclining to an upward tendency. Home consumptive demand is generally satisfactory, but Continental buying has been of a spasmodic character owing to the erratic movements of the leading exchanges. A dominant feature of interest of late has been the increasing strength evidenced in American reports, both as regards home and export market movements, which will naturally lead to some improvement in prices. Current quotations: *Cash*: Wednesday, £64 7s. 6d.; Thursday, £64 10s.; Friday, £64 5s.; Monday, £64 7s. 6d.; Tuesday, £64 7s. 6d. *Three months*: Wednesday, £65; Thursday, £65 2s. 6d.; Friday, £65; Monday, £65 2s. 6d.; Tuesday, £65.

Tin.—Movements in this section of the market have been quiet on the whole, but the undertone continues steady and fairly firm as regards current values. The volume of home demand may be regarded as satisfactory, the Welsh tinplate makers absorbing about average quantities of metal, while Continental and American consumption is reported slightly improved. The monthly statistics just published are of a somewhat adverse character, and prices fell considerably in consequence. Generally, however, future prospects for the metal are regarded with a good deal of optimism. The Straits shipments for the month of December are advised at 4,605 tons. According to one authority the total visible supply is 22,281 tons against 22,346 tons on November 30, 1922, showing a decrease on the month of 65 tons. Current quotations:—*Cash*: Wednesday, £180 2s. 6d.; Thursday, £178 17s. 6d.; Friday, £179; Monday, £179 5s.; Tuesday, £179 2s.6d. *Three months*: Wednesday, £181 12s. 6d.; Thursday, £180 7s. 6d.; Friday, £180 5s.; Monday, £180 12s. 6d.; Tuesday, £180 12s. 6d.

Spelter.—There are few movements to note in connection with this metal, most consumers being well bought to carry them over the stocktaking period. Values continue on a firm basis, with little change to note. Current quotations:—*Ordinary*: Wednesday, £36 7s. 6d.; Thursday, £35 12s. 6d.; Friday, £35 7s. 6d.; Monday, £35 12s. 6d.; Tuesday, £35 10s.

Lead.—The market during the past week has lost in strength, with values ruling lower for soft foreign prompt, but consumers' demands show a fair increase. Current quotations:—*Soft foreign (prompt)*: Wednesday, £26 15s.; Thursday, £26 15s.; Friday, £26 12s. 6d.; Monday, £26 12s. 6d.; Tuesday, £26 12s. 6d.

Gazette.

THE SEVERN ENGINEERING COMPANY, LIMITED, are being wound up voluntarily. Mr. H. A. Sharp, 120, Colmore Row, Birmingham, has been appointed liquidator.

THE INDUSTRIAL FOUNDRY AND ENGINEERING COMPANY, LIMITED, are being wound up voluntarily, with Mr. H. A. Sharp, 120, Colmore Row, Birmingham, as liquidator.

THE SHAREHOLDERS OF the Foundry and Machine Company, Limited, have agreed to wind up the company voluntarily, with Mr. W. H. Brown, 193 Coleman Street, E.C.2, as liquidator.

THE PARTNERSHIP heretofore subsisting between Messrs. G. Bell and J. P. Dodd, consulting engineers, 6, Lombard Street, Newcastle-upon-Tyne, under the style of Bell and Dodd, has been dissolved.

MR. R. BROWNLOW, Prospect Villa, Beechen Cliff, Bath, now or lately trading as the Griffin Engineering Co., Limited, Kingston Engineering Works, Bath and 68, St. James Street, London, S.W., engineer, has been adjudicated bankrupt.

THE SHAREHOLDERS OF the Electro-Metallurgical Extraction, Limited, have decided that the company be wound up voluntarily. Mr. J. A. Charlton, Bank of England Chambers, Tib Lane, Manchester, has been appointed liquidator.

A.T.F. Meeting.—Next Sunday, Mons. Ronceray is to lecture under the auspices of the Association Technique de Fonderie, at Charleville (Ardennes), on the "Making of Castings Without Feeding Heads."

Personal.

THE LATE SIR RICHARD MARTIN, J.P., of Uplands, Swansea, a director of the Swansea Vale Spelter Company, Limited, left £4,383.

THE LATE MR. G. H. ALCOCK, who for some time was connected with John Summers & Sons, Limited, steel makers, of Chester, left £2,658.

MR. R. T. SMITH has resigned his seat on the board of Baldwins, Limited, and has been succeeded by Sir Thos. Williams, a director of the London & North-Western Railway Company.

MR. HENRY BEER, after a connection of fifty-two years with the business of Sharps & Wilkins, metal brokers, of 19, Great Winchester Street, E.C., has decided to retire. The business will be continued by the other partners, Mr. Philip A. Wilkins and Mr. Lewis Balfour, under the same style as before.

MR. CECIL M. SANDERS, who for some time has acted as representative in Western Europe for the Consolidated Steel Corporation of America, has again taken up an appointment with Sanders Bros. & Company, Limited, metal merchants and agents, of 139, Fenchurch Street, London, E.C.3, to manage their business.

MR. THOS. FALCON, district manager at the Irthlingborough (Northamptonshire) works of the Ebbw Vale Steel, Iron and Coal Company, Limited, just prior to his departure for South Wales, was the recipient of a presentation from the officials and men. Mr. Falcon is leaving to take up a position under Richard Thomas & Company, Limited.

CONSEQUENT UPON THE retirement of Sir Henry M. Grayson from the chairmanship of H. and G. Grayson, Limited, shipbuilders, ship-repairers, etc., Liverpool, Garston and Birkenhead, Mr. G. H. Potter has been elected to the position. Mr. Potter has had a lengthy association with Merseyside shipbuilding, having been the principal of Messrs. W. H. Potter and Sons. When that company was taken over by H. and C. Grayson, Mr. Potter was elected a director.

MR. THOMAS SITCH, who has been secretary to the Chainmakers' and Strikers' Association for many years, is about to retire from that position owing to ill-health. It is not expected that he will entirely cease his connection with the Society, as the executive council desire him to act in an advisory capacity. Mr. Chas. H. Sitch, M.P. for Kingswinford Division, has been appointed secretary and organiser to the Chainmakers' and Strikers' Association in succession to his father.

MR. S. WOOD, the new works manager to Henry Bessemer & Company, Limited, was formerly manager of the tyre department of Steel, Peech & Tozer, Limited, where he started his career as a draughtsman after training under Dr. Ripper at the Sheffield Technical School. At an early age he became assistant to his father, then manager of the tyre department, and succeeded him on his retirement in 1903. The new manager of the steel department of Henry Bessemer & Company, Limited, is Mr. J. N. Kilby, who has retired from the position of manager of the Templeborough steel works of Steel, Peech & Tozer, Limited.

HARRIS BROS.
(Late PETER HARRIS),
METAL BROKERS, MINERAL — AGENTS, and CARRIERS.—
BRIERLEY HILL, STAFFORDSHIRE

Red Moulding Sand.
SUPPLYING OVER 30 LARGE FOUNDRIES.
PUT ON RAIL L.N.W. and G.W.R.
Enquiries Solicited—
J. STOKES,
TRENCH CROSSING,
WELLINGTON, Salop.

MACNAB & Co.

TABOR MOULDING MACHINES (TABOR PATENTS)

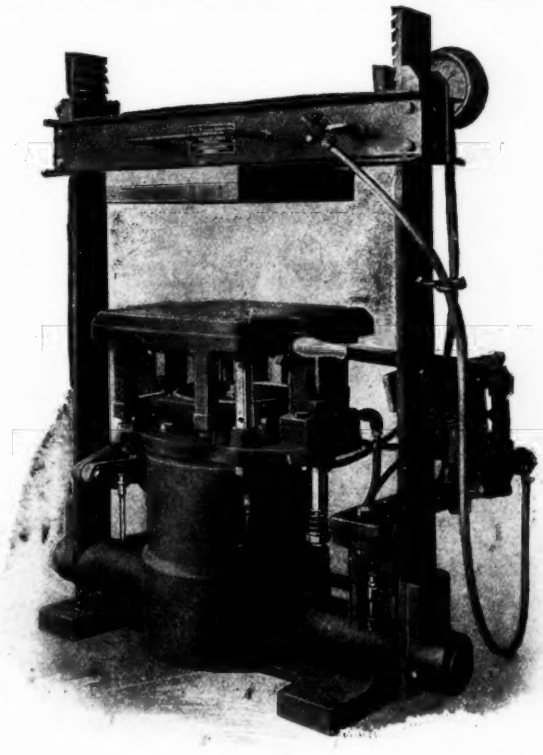
For Every Class of Work.

Pit Type and Portable Combination Shockless Jar Ramming Power Roll-over and Pattern Drawing Machines; Power Squeezing and Jar Squeezing Machines; Shockless Jarring Machines, etc., etc.

SPECIAL FEATURES AND ADVANTAGES:

Accurate Definite Draw with Permanent Accurate Alignment.

All Operations Controlled by One Lever.



Uniformity in size of Castings produced.

All Moulds squeezed alike to whatever Pressure Required.

Minimum Percentage of Wasters.

The above illustrates the TABOR POWER SQUEEZING "SPLIT PATTERN" MOULDING MACHINE, specially suitable for all small patterns which can be split in halves or for flat back work.

Capacities and Dimensions furnished upon application:

56/8, Eagle Street, Southampton Row, London, W.C.1.

Works: TOTTENHAM, LONDON, N.17.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	64	7	6
Three months	65	0	0
Electrolytic	71	10	0
Tough	68	0	0
Best selected	68	0	0
Sheets	96	0	0
India	82	10	0
Wire bars	71	15	0
Do. Jan.	71	12	6
Do. Feb.	71	12	6
Ingot bars	71	15	0
H.C. wire rods	75	15	0
Off. aver. cash, Dec. 63	6	9	6/10
Do. 3 mths., Dec. 64	2	9	15/16
Do. Settlement Dec. 63	5	9	9/10
Do. Electro, Dec. 70	6	3	15/16
Do. B.S., Dec.	67	10	0
Aver. spot price, copper, Dec.	63	5	9½
Do. Electro, Dec.	70	10	0

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10½d.
Yellow metal rods 6⅞d.
Do. 4x4 Squares 8¼d.
Do. 4x3 Sheets 9¼d.

BRASS.

Solid drawn tubes 11⅜d.
Brazed tubes 13½d.
Rods, drawn 10⅜d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. 10d.
Wire 9⅞d.
Rolled metal 9½d.

TIN.

	£	s.	d.
Standard cash	179	2	6
Three months	180	12	6
English	179	0	0
Bars	181	0	0
Chinese	177	0	0
Straits	180	17	6
Australian	180	7	6
Eastern	183	5	0
Banca	179	15	0
Off. aver., cash, Dec.	178	15	6 6/10
Do. 3 mths., Dec.	180	0	3 15/16
Do. Sttlment, Dec.	178	18	3 5/16
Aver. spot, Dec.	178	14	2½

SPELTER.

	£	s.	d.
Ordinary	35	10	0
Remelted	34	10	0
Hard	28	0	0
Electro 99.9	42	10	0
English	37	0	0
India	29	0	0
Prime Western	37	0	0
Zinc dust	49	0	0
Zinc ashes	11	0	0
Off. aver., Dec.	36	4	11 4/10
Aver., spot, Dec.	37	15	1½

LEAD.

	£	s.	d.
Soft foreign ppt	26	12	6
English	28	0	0
Off. average, Dec.	25	15	9 9/10
Average spot, Dec.	26	1	7

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	43	0	0
Do. V.M. ex whf.	43	0	0
Dutch	43	0	0
Rods	50	0	0
Boiler plates	41	0	0
Battery plates	43	0	0

ANTIMONY.

	£	s.	d.
English regulus	27	0	0
Special brands	33	10	0
Chinese	24	10	0
Crude	17	0	0

QUICKSILVER.

Quicksilver £11 5 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
45/50%	11	17	6
75%	20	10	0

Ferro-vanadium—
35/40% .. 17/- lb. va.

Ferro-molybdenum—
70/75% c. free 9/3 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/1½ lb.

Ferro-phosphorus, 20/23%, £24

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% .. .. 1/11 lb.

Ferro-chrome—
4/6% car. £22 10
6/8% car. £21 15
8/10% car. .. £21 5

Ferro-chrome—
Max. 2% car. .. £54 0
Max. 1% car. .. £65 0
Max. 0.70% car. £73 0
67/70%, carbonless 1/8 lb.

Nickel—99%, cubes or pellets .. £130 0

Cobalt metal—98/99% 11/9 lb.

Aluminium—98/99% £95

Metallic Chromium—
96/98% .. .. 4/6 lb.

Ferro-manganese (net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14

Metallic manganese—
94/96%, carbonless 2/3 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten .. .. .. 2 6 s. d.
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. .. 3d. lb.
Packing .. .. £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy steel	4	0	0	4	10	0
Bundled steel & shearings	3	5	0	4	0	0
Mixed iron & steel	3	12	6	3	17	6
Heavy cast iron	3	15	0	3	17	6
Good machinery for foundries	3	15	0	4	5	0

Cleveland—	£	s.	d.
Heavy steel	3	10	0
Steel turnings	2	15	0
Cast-iron borings	2	15	0
Heavy forge	4	2	6
Bushelled scrap	3	12	6
Cast-iron scrap	3	16	0

Lancashire—	£	s.	d.
Cast-iron scrap	4	2	6
Heavy wrought	3	11	3
Steel turnings	2	10	0

London—	£	s.	d.
Copper (clean)	57	0	0
Brass (clean)	33	0	0
Lead (less usual draft)	23	0	0
Tea lead	20	0	0
Zinc	22	10	0
New aluminium cuttings	64	0	0
Braziery copper	48	0	0
Gun metal	44	0	0
Hollow pewter	150	0	0
Shaped black pewter	90	0	0

Above are merchants' buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	96/6
Foundry No. 3	92/-
Forge No. 4	82/6
Mottled	80/-
Hematite No. 1	94/-
Hematite M/Nos.	93/6
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast, ord.	190/-
,, ,, roll iron	200/-
,, basic	—
Northants forge	71/- to 72/6
,, foundry No. 3	78/6 ,, 80/-
,, basic	80/-
Derbyshire forge	75/-
,, foundry No. 3	82/6
,, basic	80/-
Scotland—	
Foundry No. 1	100/6
,, No. 3	95/6
Hematite M/Nos.	105/-
Sheffield (d/d district)—	
Derby forge	82/6
,, foundry No. 3	85/-
Lincs. forge	86/6
,, foundry No. 3	87/6
,, basic	86/6
E.C. hematite	103/9
W.C. hematite	108/9
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	90/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	110/6
Glengarnock foundry	114/-
Gartsherrie foundry	112/6
Monkland foundry	110/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	12	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	£10 10 to 10	15	0
Bolts and nuts, ¾ in. × 4 in.	16	10	0

Steel—	£	s.	d.
Ship plates	£9 to 9	10	0
Boiler plates	12	0	0
Chequer plates	10	5	0
Angles	£8 10 0 to 9	0	0
Tees	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3 in. to 5½ in.	10	0	0
Rounds under 3 in. to ⅝ in.	9	15	0
Flats, over 5 in. wide and up	10	5	0
Flats, 5 in. to 1½ in.	9	10	0

	£	s.	d.
Rails, heavy	8	15	0
Fishplates	13	0	0
Hoops	11	0	0
Black sheets, 24 g.	11	15	0
Galv. cor. sheets, 24 g.	17	10	0
Galv. fencing wire. 8 g. plain	16	0	0
Rivets, ¾ in. dia.	11	15	0
Billets, soft 6 12 6 to 7	0	0	0
Billets, hard 7 5 0 to 8	0	0	0
Sheet bars 7 10 0 to 7	13	9	
Tin bars	7	13	9

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 3½
Wire	1 3¾
Rods	1 2¼
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SON, LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9¼
To 15 in. wide	1/4 to 1/10
To 18 in. wide	1/4¾ to 1/10¾
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6¼ to 2/0¼
Ingots for spoons and forks	9d. to 1/3
Ingots rolled to spoon size	1/- to 1/6
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	28.76
No. 2 foundry, Valley	27.00
No. 2 foundry, Birm.	23.00
Basic	26.96
Bessemer	29.27
Malleable	28.96
Grey forge	28.27
Ferro-manganese 80% delivered	100.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	36.50
O.-h. billets	36.50
O.-h. sheet bars	36.50
Wire rods	45.00

	Cents.
Iron bars, Phila.	2.27
Steel bars	2.00
Tank plates	1.95
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry 35/-
,, furnace 25/-
Durham & North. fdy. 21/6 to 30/-
,, furnace 26/-
Other Districts, foundry 25/- to 30/-
,, furnace 25/-

SWEDISH IRON.

Bars, hammered basis sizes—Basis price £22 to £23

Rolled Ordinary—Assortment .. } £ 17 s. 10 d. 0 to
Nail Rods—Square, round and flats .. } 18 5 0

Keg Steel nom. £38 to £40

Faggot Steel nom. £30 to £32

Blooms—Single welded .. £10 to £11

Billets—Single and double welded .. .. £13 to £14

Pig-iron—Grey, white or mottled £6 10 to £7 5 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 6 in.	
Gas ..	..57½%	Tube prices are now free.
Water	..52½%	
Steam	..47½%	

TINPLATES.

I.C.Cokes,	20×14, box		20/3
,,	28×20, ,,		41/6
,,	20×10, ,,		29/6
,,	18¾×14, ,,		21/–
I.X.		,,	47/–
I.X.X.		,,	53/–
F.C.B.Y.	21×13⅝ ,,		38/–
C.V.B.G.	16¾×15, ,,		36/–
I.C.W.	20×14, ,,		18/7½
,,	28×20, ,,		37/6
,,	20×10, ,,		26/6
,,	18¾×14, ,,		19/–
Terneplates,	28×20, ,,		37/6

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Jan. 3	64	7	6	dec.	5/–
,, 4	64	10	0	inc.	2/6
,, 5	64	5	0	dec.	5/–
,, 8	64	7	6	inc.	2/6
,, 9	64	7	6	No change	

Electrolytic Copper.

Jan. 3	71	10	0	dec.	5/–
,, 4	71	10	0	No change	
,, 5	71	10	0	,,	
,, 8	71	10	0	,,	
,, 9	71	10	0	,,	

Standard Tin (cash).

Jan. 3	180	2	6	dec.	42/6
,, 4	178	17	6	,,	25/–
,, 5	179	0	0	inc.	2/6
,, 8	179	5	0	,,	5/–
,, 9	179	2	6	dec.	2/6

Tin (English ingots).

Jan. 3	180	0	0	dec.	45/–
,, 4	179	0	0	dec.	20/–
,, 5	179	0	0	No change	
,, 8	179	5	0	inc.	5/–
,, 9	179	0	0	dec.	5/–

Zinc Sheets (English).

Jan. 3	43	0	0	No change	
,, 4	43	0	0	,,	
,, 5	43	0	0	,,	
,, 8	43	0	0	,,	
,, 9	43	0	0	,,	

Spelter (ordinary).

Jan. 3	36	7	6	dec.	2/6
,, 4	35	12	6	,,	15/–
,, 5	35	7	6	,,	5/–
,, 8	35	12	6	inc.	5/–
,, 9	35	10	0	dec.	2/6

Lead (English).

Jan. 3	28	0	0	No change	
,, 4	28	0	0	,,	
,, 5	28	0	0	,,	
,, 8	28	0	0	,,	
,, 9	28	0	0	,,	

There's something for You among these —

Blacking, Coal Dust, Plumbago, Charcoal, Core Gum, Terra Flake, Gannister, Core Oils, Sea Sand, Moulding Sand, Iron Cement, Brushes, Bellows, Buckets, Chaplets, Core Ropes, Core Tapers, Ladles, Crucibles, Cupolas, Riddles, Sprigs, Spades, Carborundum Bricks and Wheels, Ferro-Aluminium, Blacking Bags, Foundry Plant, Etc., Etc., Etc.

F. L. HUNT & CO., 56, 58, 60, Chapel Street, Salford, Manchester.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

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31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

IRON & STEEL SCRAP

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

OF INTEREST TO FOUNDRIES POSSESSING NO LABORATORY.—Metallurgist and Foundry Chemist, who has specialised for the last twenty years in all classes of foundry practice, is open to act as Metallurgical Consultant and Chemist. Advertiser has own well-equipped Laboratory for undertaking the necessary Analytical work and Tests. Confidential work and moderate charges.—Write, Box 324, FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—WORKING FOREMAN for Iron Jobbing Foundry now employing only 12 Moulders but with plenty of room for extension; must be used to machine tool work and familiar with best methods of plate, machine and jolt work; preference given to man who could introduce speciality; state wages and experience.—Box 322, FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

AGENCIES.

THE Manufacturers of the most up-to-date Moulding Machines in the world, who have over 16,000 Machines at work in the various Countries of the Universe, desire well accredited and energetic Selling Agents in all British Colonies and Possessions for the sale of their Moulding Machines, and all Foundry Plant. In reply please write to THE UNIVERSAL SYSTEM OF MACHINE MOULDING & MACHINERY COMPANY, LIMITED, 97, Queen Victoria Street, London, E.C.4.

AUCTION SALE.

Order of the Trustee, H. T. Bloor, Esq.

VICTORIA WORKS,
BRENTWOOD,
ESSEX.

HENRY BUTCHER & COMPANY

Have been favoured with instructions to Sell by Auction on the above premises at Ongar Road, Brentwood, TUESDAY, January 16, 1923, and following day,

THE VALUABLE AGRICULTURAL AND GENERAL ENGINEERS' AND IRONFOUNDERS' PLANT AND MACHINERY,
comprising approximately

9 S.S. & S.C. and other Lathes, 4 Capstan and Turret Lathes, 1 Planer 12 ft. 6 in. x 5 ft. x 2 ft., 10 heavy duty Corona and other Drilling Machines. 1 20-in. "Acme" Hacksaw, 1 12-in. Hacksaw, 4 Milling Machines by Garvin, etc., 6 Cutter Tool and other Grinders, 1 72-in. x 10-in. Landis Plain Grinder, 1 12-in. Slotting Machine,

1 37-h.p. CROSSLEY GAS ENGINE,

Forges, Vices, Surface Plates, Shafting, Pulleys, Fans,

FOUNDRY EQUIPMENT.

2 Cupolas (1 and 3 ton), 4 Gas-fired Pot Furnaces 120 lbs., 1 Air Compressor (up to 100 lbs.), 1 Overhead Crane, 50 tons Foundry Boxes, 5 tons Foundry Weights, 4 tons Pig-iron, 3 tons Coke, 1 5-ton Platform Weighbridge, 1 18-h.p. National Gas Engine, 1 Core Oven, 2 "Sturtevant" No. 3 Blowers, 1 Crab Winch, Moulding Machines, Crucibles, Rumblers, Sand Mixers.

STOCK AND STORES.

2 tons R.W. Pipes, 5 tons Bar Iron, 1 ton Steel Bars, 6 gross Files, 3 gross Twist Drills, 1 gross Taps and Reamers, 2 tons Bolts and Nuts, 200 gross assorted Screws.

DRAWINGS, PATTERNS AND STOCK OF MESSRS. BURGESS' SPECIALITIES.

Bucket Pumping Machinery, Saw Cotton Gin, Field Mower, Motor Lawn Mower, Portable Hand Baling Press.

OFFICE FURNITURE AND MISCELLANEOUS.

5 Roll Top Desks, 4 Office Tables, 6 Clocks, "Barlock" Typewriter, Safe, Copying Press, Lino, Chairs, Cabinets, Stocks, etc.

1 15-h.p. PANHARD MOTOR LORRY, 1 4-WHEEL WAGON.

The Valuable FREEHOLD LAND AND BUILDING, comprising a site of about 4 acres, and including large and well-arranged ENGINEERING AND FOUNDRY PREMISES, containing MACHINE SHOPS, FOUNDRIES, STORES, GARAGE, OFFICES, etc., having a total floor space of about 50,000 ft. super, together with a substantial Residence and two Cottages, will be offered for sale by Auction, on TUESDAY, the 16th January, 1923, at 11 a.m. precisely.

ON VIEW 7 DAYS PRECEDING THE SALE.

Particulars, Conditions and Plan, together with Catalogues may be obtained from:—

The Trustee, H. T. Bloor, Esq. (Messrs. W. F. Smart, Son & Bloor), 255, Finsbury Pavement House, E.C.2, or

Messrs. E. F. & H. Landon, Solicitors, 53, New Broad Street, London, E.C., and at Brentwood.

Messrs. Henry Butcher & Co., Auctioneers, Valuers and Surveyors, 63-4, Chancery Lane, London, W.C.2.

Phone: Holborn 741 and 742. Telegrams: "Penetancy, Holb., London."

MACHINERY.

TWO Cross Compound Horizontal Drop Valve Engines, 12½ in. and 20-in. cyls., 26 in. stroke, by Robey & Company, Limited. Cross Compound Horizontal Condensing Engine, 11½ in. and 17½ in. cyls., 18 in. stroke, by Marshall, Sons & Company, Limited. Vertical Compound Open Type Engine, 12 in. and 19 in. cyls., 12 in. stroke, by Tangyes, Limited. Nearly New Surface Condensing Plant, by F. Pearn & Company, surface area of tubes about 1,200 ft., compound engine, etc. Ingersoll Sergeant Direct Line Steam Driven Air Compressor, 14¼ in. air cyl., 14 in. steam, 14 in. stroke, capacity 384 cub. ft. free air per minute. Vertical Three-Throw Geared and Belt-Driven Hydraulic Pump, by H. Berry & Company, 2½ in. rams, 6 in. stroke, working pressure 1,500 lbs. 4 ft. Arm Bickford Radial Drilling Machine, 3 in. balanced spindle, T slotted low base 4 ft. by 3 ft. Four 3 ft. 4 in. Cold Iron Band Sawing Machines, by Noble & Lund, two T slotted tables 3 ft. 9 in. by 1 ft. 9 in. Vertical Boring and Turning Mill, with 50-in. table, two tool boxes on cross slide, by the Bridgeport Machine Tool Works, Limited. Horizontal Boring Machine, by the Lucas Machine Tool Company, 3-in. spindle, T slotted table 3 ft. 6 in. by 1 ft. 10 in.

Catalogue of Stock Machinery, 6,000 Lots, Free on application. Inspection invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

COMPLETE New Portable Cutting Plant, £15 10s.; approval. Welding Plant, with six blowpipes, £22, including expert tuition at customer's works; approval. Cutting Blowpipes, unused, but soiled, £3; 1922 pattern.—STANSELL'S ACETYLENE COMPANY, LIMITED, Exeter.

NINE nearly new Steel Hopper Wagons, standard gauge, roller bearings.

Two sets of Belt-driven Geared Hydraulic Pumps, 2-in. rams and 4-in. rams.

Brand new 4-ft. under-driven Sand Mill.

10-kw. Steam-driven Lighting Set, 110 volts D.C.; bargains.

HARRY H. GARDAM & COMPANY, LIMITED, STAINES.

PATENTS.

INVENTORS Advice, Handbook and Consultations Free. KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Regd. Patent Agent, 146a, Queen Victoria Street, London; 36 years' references.

PATENTS AND DESIGNS ACTS, 1907 and 1919.
CASTINGS.

THE Proprietor of British Letters Patent No. 142,201 is prepared to sell the patent or to license British manufacturers to work under it. It relates to a method of casting steel billets for further working. The billets are cast in shallow flat moulds having a bottom chill.—Address, B. W. & T., 111 and 112, Hatton Garden, London, E.C.1.

MISCELLANEOUS.

OFFER—STEEL.

Trial Order One Ton Hot Rolled Ribbon, 0.25 % carbon —1.) × 26 m/m ± 0.1 × 0.5 m/m ***clean*** (sand blasted?); and same Cold Rolled, 1.6 × 2.55 m/m—both delivered in rings. c.i.f. Kristiania. Offer with sample to:

MRSS. JOHANSSON & SOLBERG,
ST. HALVARDS GATE 35, KRISTIANIA. (H.O. 19996).

USEFUL MISCELLANEOUS
FOUNDRY PLANT.

Two Small Rumblers ... ... each	£10
Pneumatic Sand Sifter, by Macdonald, as new	£12
Belt-driven Sand Sifter, flat type—German	£8
EVANS ROTARY SAND SIFTER	£8
ONE 6 ft. Sandmill, revolving pan, underdriven	£50
TWO 4 ft. Sandmills, as new, also One Loam Mill, 4 ft., each	£28
TWO Pneumatic Hoists, by Tabor, as new, 6 ft. travel ...	£9
Climax Corewire Straightener ⅛in. to ¼in. capacity, by Thwaites	£16
BALL MILL for grinding coal	£22
BANDSAW for Brass Castings, by Noble and Lund	£45
EVANS Magnetic Separator, for turnings	£14
Coke-fired CORESTOVE, 14 ft. x 6 ft. x 6 ft., fine job, asbestos packed	£45
Coke-fired CORESTOVE, 4ft. x 3ft. x 3ft.	£14
CUPOLA HOIST, electric, by Tangye, New, 440/480 volts D.C., 18 ft. lift	£75
Several Wall Cranes, by Wadsworth, New, 1 ton lift, each ...	£5

SHANKS, LADLES, FURNACES & GENERAL FOUNDRY PLANT & MACHINERY OF ALL KINDS ALWAYS IN STOCK

ALEXANDER HAMMOND, FOUNDRY MACHINERY MERCHANT,
BOXTED, SLOUGH.